The Dissertation Committee for Ronghong Nie Certifies that this is the approved version of the following dissertation:

Preferences for Health Information and Decision-making Autonomy Among Chinese Patients with T2DM in the mHealth Era

Committee:

Bo Xie, Supervisor

Gayle Acton, Co-Supervisor

Sharon A Brown

Le Zhou

Preferences for Health Information and Decision-making Autonomy Among Chinese Patients with T2DM in the mHealth Era

by

Ronghong Nie BSN, MSN

Dissertation

Presented to the Faculty of the Graduate School of

The University of Texas at Austin

in Partial Fulfillment

of the Requirements

for the Degree of

Doctor of Philosophy

The University of Texas at Austin

August 2017

Acknowledgements

It would have been incredibly difficult to complete this dissertation without the assistance, expertise, and encouragement of many people. First, I express my utmost thanks to Dr. Bo Xie, the chair of my committee, for her guidance and inspiration over the years. Without her, this work would not have been possible. Dr. Bo Xie's professional judgment regarding the quality of my research and manuscript was exceptional. Her support and advice will not be forgotten. She listened to my thoughts and ideas, and she gave me the opportunity to explore while keeping me on track. She even met me on campus to discuss my study on the weekends to accommodate my work schedule. I have greatly benefited from and will very much miss her warm personality and sharp intellect.

I would also like to thank my committee, Dr. Gayle Acton, Dr. Sharon A Brown, and Dr. Betty Zhou, for their comments, feedback, and encouragement. Their insight, suggestions, and expertise challenged me and helped me focus on the concepts of diabetes self-management, descriptive research, mobile health, theoretical framework development, and statistical analysis.

Dr. Acton came to my workplace weekly to meet me for one of my independent studies during the summer. She accommodated my work schedule and spent countless hours assisting me in learning nursing theory and developing my study framework. This formed the basis of my doctoral work.

In her critical review class, Dr. Brown took us step-by-step through writing grants and proposals and critiquing professional papers. Without her instruction and guidance, it would have been hard to know where to start to write. Additionally, Dr. Brown's expertise on diabetes greatly influenced me to study Chinese patients' self-management of their type 2 diabetes for my dissertation.

Dr. Zhou has generously spent countless hours assisting me on the survey instrument revision and statistical analysis of data.

I would also like to thank Dr. Taxis and Dr. Stuifbergen for their encouragement and continuous support during my doctoral program. Without their encouragement and support I would have had difficulty in continuing on my doctoral journey. I would also like to thank the professors at the University Of Texas School Of Nursing and School of Education, as well as the library and research lab staff there, who have offered so much assistance and help whenever I needed it.

I am very grateful for my site collaborator, Dr. Yan Yang, and the staff at the Sichuan Academy of Medical Science/Sichuan Provincial People's Hospital in Chengdu, China. They provided the research study site to collect the data for my pilot and dissertation studies. Without their support, it would have been difficult to complete these studies.

I thank Dr. Leigh Goldstein who encouraged me to return to my doctoral studies and constantly offered assistance and help.

I am very thankful to my leadership team, co-workers, and staff at St David's North Austin Medical Center and St David's Institute for Learning for their support and understanding of my study. I am also grateful for my dear friends and colleagues, Amber Shammas and Donna Robinson, who have given me enormous encouragement.

None of this would have been possible without my family's support and love, in particular, the care and support of my husband and my children who were all there for me during many challenges. My children were always my first readers, correcting grammar and spelling, and without my loving husband's encouragement and support, I couldn't even have started this journey. Thank you!

Preferences for Health Information and Decision-making Autonomy Among Chinese Patients with T2DM in the mHealth Era

Ronghong Nie, PhD

The University of Texas at Austin, 2017

Supervisor: Bo Xie

Co-supervisor: Gayle J Acton

This quantitative descriptive study explored preferences for health information and decision-making and for mobile health (mHealth) use in Chinese patients with type 2 diabetes (T2DM). Specific aims of this study were: to explore (1) individual preferences for the types and amounts of health information and decision-making autonomy among Chinese patients with T2DM; (2) their use of mobile technology in their self-management of the condition; and (3) the relationship between their use of mHealth and their preferences for health information and decision-making autonomy. The sample consisted of 200 Mandarin-speaking Chinese patients from 26 to 90 years of age (mean age 59.91; SD: 12.17) with T2DM and a mean of 7.4 years since diabetes diagnosis. Data were collected via a pen-and-paper survey questionnaire at a general hospital in Chengdu, the capital of Sichuan province, China. The survey questionnaire measured preferences for health information and decision-making autonomy and mHealth use. The study results provided empirical evidence that Chinese patients with T2DM wanted to have a wide range of health information and participation in decision-making. Gender, health status,

and knowledge about the condition were associated with differences in information wanted and participation in decision-making, but age was not. Half (50.5%) of the participants used smartphones to access the Internet and look for health or medical information; 71% of participants used smartphones to receive/read health-related posts; and 24% of participants had at least one health-related application downloaded to their smartphones. Smartphone use frequency for health information and participation in decision-making had a statistically significant interaction, the strength of which varied across seven subscales (specific health condition, treatment, laboratory tests, self-management, complementary/alternative medicine, psychosocial aspects, and healthcare providers). The overall health information wanted had a positive relationship with using smartphones to receive health-related posts. This study has implications for research and clinical practice, especially given the shift from disease-centered to patient-centered care.

Table of Contents

List of Tables

List of Figures

CHAPTER 1: INTRODUCTION

In the United States, there is a movement to improve healthcare by reducing costs while advancing health services and patient outcomes (HealthyPeople, 2020). Mobile Health (mHealth) offers a cost-effective strategy for achieving this goal (Buhi et al., 2012), and it is thought that mHealth can effectively promote health awareness and well-being for those with diabetes (Arnhold, Quade, & Kirch, 2014; El-Gayar, Timsina, Nawar, & Eid, 2013). In 2014, 90% of American adults owned a cellphone, 64% of American adults owned a smartphone, and 67% of cellphone owners checked their phone for messages and alerts (Pew Research Center, 2014). Additionally, 62% of American smartphone owners have used their phones to look for information about a health condition (Pew Research Center, 2015).

The high adoption rate of mobile phones in China (Pew Global Attitudes Project, 2011; Mobithinking, 2014) similarly suggests that mHealth offers an opportunity to improve health promotion activities and induce changes in behavior among Chinese patients with diabetes (Zhou et al., 2016). China is the largest global mobile phone consumer, with 1.05 billion mobile phones used (mobiThinking, 2014). In 2016, 98% of Chinese owned a cellphone, and 68% owned a smartphone (Pew Research Center, 2017).

China accounts for about one third of the global diabetes population; as such, China’s diabetes-related economic burden is a major public health challenge (X. Li et al., 2015). China spends RMB 173.4 billion (US $25 billion) a year on the management of diabetes, and 13% of China's medical expenditures are directly related to diabetes (Cheng, 2011). Furthermore, diabetes is related to increased risks for kidney and heart disease, stroke, and blindness (Centers for Disease Control and Prevention [CDC], 2012; Xi et al., 2012; Zhao, Zhao, Li, & Zheng, 2012).

After patient education by healthcare professionals, diabetes requires ongoing medical care and extensive patient self-management (El-Gayar et al., 2013; van Vugt et al., 2013), in fact, as 98% of diabetes care is managed by patients themselves, and daily decision-making by patients in diabetes care is critical (Anderson & Funnell, 2002; Bravo et al., 2015). Effective diabetes self-management depends on patients' receiving ongoing psychosocial support, as well as sufficient information about a variety of different topics, including the disease itself, treatment options, diet and nutrition, physical activities, safe use of medications, blood glucose monitoring, self-administration of insulin, and prevention and treatment of complications (Haas et al., 2013). Yet patients with diabetes do not consistently adhere to an ideal pattern of behavior because the behaviors changes are hard to make and can be even harder to sustain with diabetes patients (Chew, Shariff-Ghazali, & Fernandez, 2014; Delamater, 2006). However, the risk of complications of diabetes can be reduced by proper adherence of behaviors changes (Delamater, 2006). Thus, patients with diabetes must change their behaviors and habits over time (Buhi et al., 2012; Lin et al., 2014; Ma, Xiao, & Blonstein, 2013; Park, Howie-Esquivel, &

Dracup, 2014; Piette et al., 2015). The provision of adequate health information and empowerment of patients can improve self-management practices and enhance health outcomes (Camerini et al., 2012; Elbert et al., 2014) if patients acquire the proper skills (Caburnay et al., 2015; Wong et al., 2011).

Empowerment is at the core of self-management. Empowerment is achieved when patients are actively involved in their own care and when healthcare providers offer services based on patients' personal needs and preferences. If healthcare services do not fit patients' personal needs and preferences, patients will not feel empowered, and healthcare providers may not be to improve their patients' quality of life or improve important healthcare outcomes (Aujoulat, d'Hoore, & Deccache, 2007; Epstein & Street, 2011; Tol, Alhani, Shojaeazadeh, Sharifirad, & Moazam, 2015; Wildevuur & Simonse, 2015).

Although patients are overwhelmingly interested in having detailed information, about their healthcare needs and problems, however, they participate much less in healthcare decision-making (Deber, 1996; Stigelbout &Kiebert, 1997; Xie, 2009). Why do patients want information even if they do not want to use it to make decisions, and what do patients intend to do with the information after they obtain it? Xie's (2009) research and development of the health information wants (HIW) framework answers these questions. Additionally, Xie has applied the concepts of health information-seeking and decision-making preferences to the online world (Xie, 2009).

The HIW framework is a patient-centered care model that offers a new approach to explaining preferences for participation in decision making and a new perspective on how patients' health information wants may differ from what healthcare providers think patients need. The HIW framework promotes an understanding of the patient's preferences from the perspective of the patient rather than that of the healthcare provider (Xie, 2009; Xie et al., 2015). The subsequently developed HIW questionnaire (HIWQ), constructed from research findings and with guidance from the HIW framework, includes subscales for seven types of health information and decision-making: information and decision-making about the specific health condition (e.g., diabetes), treatment, laboratory tests, self-management, complementary/alternative medicine (CAM), psychosocial support, and healthcare providers (Xie, 2009; Xie et al., 2013; Xie et al., 2015).

The information that patients with diabetes need in order to keep track of their disease can become overwhelming, and patients with diabetes who want more advice from their healthcare providers are often frustrated because they lack contact with providers between office visits (Kart, 2016; Shetty & Hus, 2016). mHealth uses mobile phones, patient monitoring devices, PDAs, and other wireless devices (Rouse, 2016). Because mHealth devices collect clinical health data; share healthcare information among healthcare providers, researchers, and patients; and promote real-time monitoring and direct provision of care (Germanakos, Mourlas, & Samaras, 2005). Thus mHealth has opened up exciting new ways for patients to keep track of their information and stay connected with healthcare providers (Kart, 2016).

Living with diabetes is a full-time job. *Healthy People 2020's* objectives specifically recommend self-management education for those with diabetes. Few research studies have addressed how Chinese patients with type 2 diabetes (T2DM) make decisions regarding their diabetes, especially regarding choosing care based on their needs and preferences; how mHealth has been used by Chinese patients with T2DM; and whether mHealth can facilitate self-management in Chinese patients with T2DM.

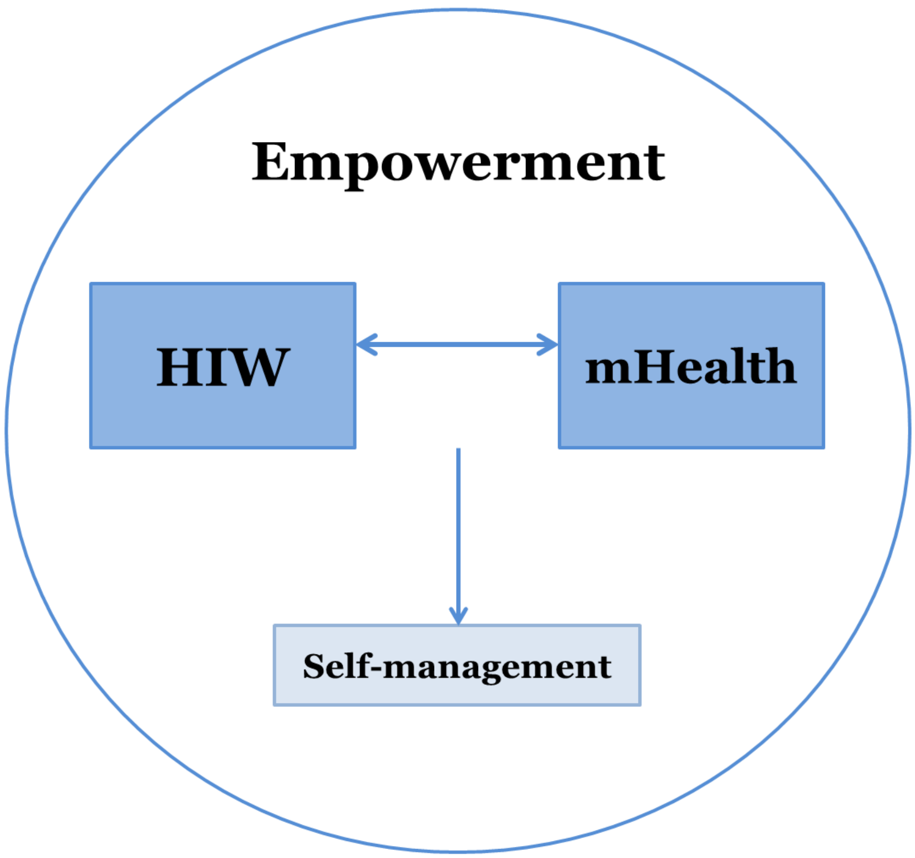
PURPOSE

This quantitative, cross-sectional study is built on Xie et al.'s (2015) study of health information wanted and obtained by Chinese cancer patients and family caregivers from doctors and nurses, and a pilot study that we conducted during the summer of 2016 on health information preferences and decision-making autonomy in Chinese patients with T2DM self-management. In that study, we explored (1) preferences for types and amounts of health information and participation in decision-making autonomy in Chinese patients with T2DM; (2) how mHealth is used by Chinese patients with T2DM; and (3) the relationship between mHealth use and preference for types and amount of health information and participation in decision-making.

STUDY FRAMEWORK

This study's framework is based on four key concepts: (1) health information wants (HIW); (2) mHealth; (3) empowerment; and (4) diabetes self-management (see Figure 1).

Figure 1: Study Framework



The HIW framework is a patient-centered care model that focuses on patient's preferences for health information and participation in decision making and on how patients' wants may differ from what healthcare providers think patients need. It promotes an understanding of the patient's preferences from the patients' perspective rather than from the healthcare provider's perspective (Xie, 2009; Xie et al., 2015).

mHealth is bringing fundamental changes to clinical practice through improved access to health information (Kart, 2016; Hartin et al., 2016) and participation in decision-making (Hartin et al., 2016; Riaz & Atreja, 2016). Healthcare providers may not be the ideal source to meet the patients' needs for health information seeking because of their limited time and lack of easy access by the patients (Xie, 2009), and mHealth, especially through the use of smartphones (due to ease of use, accessibility, mobility, and connectivity), offers a new opportunity for patients to access or seek health information about their conditions (Lee, 2016). This can empower patients, enabling them, for example, to access their personal information and electronic health records and to schedule doctor's appointments through their mobile devices (Kart, 2016). mHealth encourages patients to take an active role in the management of their own health by providing patients with information and knowledge required to understand their health status and to make informed decision (Calvillo et al., 2013). Empowered patients may become more responsible for and involved in their treatment, modify their behavior, and better collaborate with their healthcare providers (Calvillo et al., 2013).

Empowering patients requires healthcare providers to offer services based on patients' personalized needs and preferences. If healthcare services are not personalized according to patients' needs and preferences, patients cannot be empowered, and healthcare providers may not improve their patients' quality of life or improve important healthcare outcomes (Aujoulat, d'Hoore, & Deccache, 2007; Epstein & Street, 2011; Tol, Alhani, Shojaeazadeh, Sharifirad, & Moazam, 2015; Wildevuur & Simonse, 2015). Thus empowerment is at the core of self-management and patient-centered care. This is important especially for the condition of diabetes, which requires extensive self-management. Persons with diabetes can be empowered when they receive sufficient information through both healthcare professionals and mobile devices about the disease, treatment options, diet and nutrition, physical activities, safe use of medications, and blood glucose monitoring, as well as by mobile devices facilitating compliance in following-up with healthcare providers (Hartin et al, 2016; Kart, 2016).

SIGNIFICANCE OF THE STUDY

This study is significant for several reasons. The prevalence and burden of diabetes are increasing in China is enormous; China has the highest prevalence of people with diabetes in the world; there is a lack of research on preferences for health information and decision-making autonomy in Chinese patients' self-management of T2DM; there is a lack of knowledge about how mHealth has been used by Chinese patients with T2DM; and there is a lack of knowledge about the relationship between mHealth use and preference for types and amounts of health information and participation in decision-making among Chinese patients with T2DM. Empowerment is critical for T2DM self-management—if T2DM patients can be empowered to care for themselves, their health outcomes will likely be improved. This study's adaptation of the HIW framework will provide insight and understanding regarding preferences for types and amounts of health information and participation in decision-making autonomy of Chinese patients with T2DM, and this insight may shed light on future research to improve self-management. mHealth survey questions will provide information about how mHealth can be utilized by Chinese patients for T2DM self-management. The results will inform the development of future mHealth applications (apps) to aid effective diabetes self-management.

BACKGROUND

Diabetes is one of the most common chronic diseases worldwide (Guariguata et al., 2014; Hernandez-Tejada et al., 2012; Shaw, Sicree, & Zimmet, 2010). In 2013, diabetes affected 382 million adults, and this number is estimated to increase to 592 million by 2035 (Guariguata et al., 2014). In the U.S., 18.8 million cases of diabetes have been diagnosed, 7 million cases are estimated to be undiagnosed, and with an additional 79 million cases of prediabetes, more than 100 million people are at risk for developing diabetes complications (Haas et al., 2013). Furthermore, 4.9 million patients with diabetes died from diabetes-related complications in 2014 alone (Scheibe, Reichelt, Bellmann, & Kirch, 2015).

Diabetes in China

China has the highest prevalence of people with diabetes in the world (Guariguata et al., 2014). In 2013, 98.4 million Chinese between the ages of 20 and 79 years had diabetes, and this number is expected to increase to 142.7 million by 2035 (Guariguata et al., 2014). China accounts for about one third of the global diabetes population, with a diabetes-related economic burden of more than $550 billion in 2014 (X. Li et al., 2015), which is the world's largest economic diabetes burden (Cobden, Niessen, Barr, Rutten, & Redekop, 2010; Y. Xu et al., 2013). Because the prevalence of diabetes increases with age, it is expected that 50% of Chinese 65 years or older will develop this disease (S. Li et al., 2015; X. Li et al., 2015). This is a huge problem for both patients and their families (Wong et al., 2011).

Nevertheless, only about a quarter of Chinese patients with diabetes receive medical help, blood glucose is well managed in fewer than 40% of patients, and 83% of patients with diabetes have complications of hyperlipidemia, hypertension, and neuropathy (X. Li et al., 2015). In addition, Chinese healthcare providers do not typically give their patients sufficient information about diabetes (Hua et al., 2013; Tang et al., 2002; Xie et al., 2015), resulting in a lack of diabetes-related information and self-management practices among the majority of Chinese patients (Zhou, Liao, Sun, & He, 2013). Diabetic retinopathy, for example, is a complication for which laser treatment is the standard of care, yet 45% of Chinese patients with diabetes either do not receive this treatment or do not complete it (Hua et al., 2013). A main reason for noncompliance is patients' lack of treatment information (Hua et al., 2013). Such a lack of information not only results in severe consequences, including the diabetes-related complications of retinopathy, nephropathy, neuropathy, cardiovascular disease, thrombosis, stroke, and low quality of life (Hassan et al., 2014; Nathan, 1993; van Vugt et al., 2013), but also makes patients feel powerless with respect to diabetes treatment and self-management (Camerini et al., 2012).

Patient Empowerment

The concept of patient empowerment covers situations in which patients are encouraged to take an active role in the management of their own health (Calvillo, Roman, & Roa, 2013). Patient empowerment in health is a process of helping patients to assert control. Powerlessness in healthcare is related to poor health, and empowerment in healthcare is related to improved health (Camerini et al., 2012). With respect to diabetes, empowerment has been defined as "a patient-centered, collaborative approach tailored to match the fundamental realities of diabetes care," and the patient's empowerment consists of "helping patients discover and develop the inherent capacity to be responsible for one's own life" (Funnell & Anderson, 2004).

Key to the concept of empowerment is power, which can be changed and expanded (Page & Czuba, 1999). Power is related to the capacity to make people do what they want, but it is also created in relationships with others, such that empowerment becomes a process of change, shared with people with whom they are working, and growing in meaning (Page & Czuba, 1999). An empowerment approach offers a care model for increasing diabetes patients' sense of self-efficacy and for improving methods to help them make decisions and changes in their disease self-management (Anderson & Funnell, 2002; Aujoulat et al., 2007; Camerini et al., 2012; Heisler et al., 2003; Rossi et al., 2015). To become empowered, patients must be sufficiently well informed to so that they are active partners or collaborators in their own care. Healthcare professionals empower patients by providing health information, education, and psychosocial support so that patients can make informed decisions in order to achieve their goals and overcome barriers (Aujoulat et al., 2007; Rossi et al., 2015; Tol et al., 2015).

Within a philosophy of empowerment in healthcare, people also have the right and capability to select and do things for themselves; self-determination is a strong element in empowerment-based interventions (Aujoulat et al., 2007). Conceptually, empowerment involves both the provider–patient interaction, where knowledge, values, and power are shared by patients and providers through communication and education, and the patient alone, where the patient undergoes a process of transformation as he or she acquires power (Aujoulat et al., 2007). Both concepts aim toward outcomes that give patients more power over their lives (Aujoulat et al., 2007; McAllister, Dunn, Payne, Davies, & Todd, 2012).

Empowerment can be measured by the extent to which patients gain knowledge about their own disease and treatment. Patients, for example, require knowledge in order to control their blood glucose (Aujoulat et al., 2007; Goh et al., 2015; Peña-Purcell, Boggess, & Jimenez, 2011). One linear regression study revealed that empowerment in patients with diabetes was a statistically significant predictor of behavior changes in diet, exercise, blood glucose testing, medication protocol adherence, and reduction in glycated hemoglobin (A1C) in the Chinese population (S. Yang, Hsue, & Lou, 2014). Another empowerment outcome is improved psychosocial well-being, which can be measured by changes in patients' quality of life in relation to their environment as they acquire psychosocial skills to resume daily activities and change their behaviors, such as improving their diet, losing weight, and adhering to medication regimens (Aujoulat et al., 2007; Goh et al., 2015; Piette et al., 2015; van Vugt et al., 2013). Acquired psychosocial skills also empower patients to address illness-related issues such as powerlessness, fear, or anxiety (Young-Hyman et al., 2016).

Evidence indicates that self-management and shared decision-making are the most common outcomes of patients' empowerment (Aujoulat et al., 2007), and patient-centered outcomes including psychosocial well-being (satisfaction with diabetes treatment, perceived social support, lower levels of stress about diabetes) and self-care activities (diet, exercise, foot care, monitoring blood glucose, and medication compliance) have been significantly improved (Rossi et al., 2015; Wildevuur & Simonse, 2015). Patients' empowerment results in patients becoming self-determining agents who are able to control their health and healthcare as they become active rather than passive healthcare recipients (Aujoulat et al., 2007; Bravo et al., 2015; McAllister et al., 2012).

Diabetes Self-Management

Self-management may be defined as the skills that patients with one or more chronic conditions must have in order to live well and deal with the medical and emotional management of their disease on a daily basis (El-Gayar et al., 2013). The American Diabetes Association (ADA) has defined diabetes self-management as including dietary adjustment, physical activity, management of medications, glucose self-monitoring, and compliance with medical appointments (Caburnay et al., 2015; Chomutare, Fernandez-Luque, Årsand, & Hartvigsen, 2011; Ristau, Yang, & White, 2013; Wong et al., 2011).

Self-management has been promoted globally as signifying patients' management of their health conditions through empowerment that enables patients' independence (Chomutare et al., 2011; Silver, 2015). The foundations of diabetes care are diabetes self-management education and support (ADA, 2015), and diabetes self-management education is critical to diabetes care (Haas et al., 2013). Effective diabetes self-management depends not only on ongoing psychosocial support, but also on patients' receiving sufficient information about the disease, treatment options, diet and nutrition, physical activities, safe use of medications, blood glucose monitoring, self-administration of insulin, and prevention and treatment of complications (Haas et al., 2013).

The self-management of T2DM is complex and demanding, however, involving the self-monitoring of blood glucose and the modification of one's diet and behaviors. Diabetes self-management is fundamentally different from other, more easily adopted health-related behaviors like seatbelt use for safer driving. In addition, although there is a big demand within the healthcare system to provide diabetes self-management education and support networks (Haas et al., 2013; Rossi et al., 2015), not enough diabetes educators are available (Sultan & Mohan, 2012), and healthcare resources are limited (Weymann, Härter, & Dirmaier, 2016). Finally, not all patients with diabetes have the ability to access diabetes information (Weymann et al., 2016). Currently, many diabetes-related mHealth apps have been developed to support patients' self-management (Arnhold et al., 2014). Advances in technologies such as smartphones offer new opportunities to increase and enhance diabetes self-management (El-Gayar et al., 2013). Yet despite the high prevalence of T2DM and poor diabetes outcomes in China, to date, not many studies have attempted to explore how mHealth has been used by and might facilitate self-management in Chinese T2DM patients.

We have examined features and types of health information provided by existing Chinese diabetes mobile apps (Nie, Xie, Yang, & Shan, 2016). In that study we found that blood glucose monitoring was enabled by 65% of the apps. Diet management, insulin checking, and physical activities monitoring were enabled by 53%, 49%, and 44% of the apps, respectively. Only a small percentage of the apps enabled psychosocial support (29%), tracking of blood pressure information (14%), and tracking of cholesterol information (14%). And only a small percentage of the apps provided information about laboratory tests (29%), healthcare providers (21%), and CAM (7%). Not providing a comprehensive resource for recording and accessing all these types of information is a missed opportunity that should be addressed (Nie et al., 2016; Young-Hyman et al., 2016).

Disease-Centered Model

In a purely disease-centered model, standard medical care is offered to patients, diagnoses are made according to systematic clinical guidelines, and care plans focus on the disease itself, with treatments based on clinical experience and evidence from medical tests (Anderson & Funnell, 2002; Green, Carrillo, & Betancourt, 2002). Diabetes, however, is a chronic disease that requires extensive, continuous medical attention, education, and support. Traditional management of patients with diabetes has consisted of measuring compliance with therapeutic regimens and techniques (Funnell & Anderson, 2004; Hernandez-Tejada et al., 2012), but such an approach does not agree with the realities of diabetes care, and it is insufficient over the long term (Funnell & Anderson, 2004). It undervalues the psychosocial and humanistic aspects of patients' care

(Green et al., 2002). The traditional approach does not fit with patients' preferences, cultures, or lifestyles (Funnell & Anderson, 2004; Rossi et al., 2015), it negatively affects treatment compliance, and it has led to poorer outcomes (Green et al., 2002; Hernandez-Tejada et al., 2012).

Ninety-eight percent of diabetes care is done by the patient. Adult patients are more willing to make changes in their care if the changes are meaningful and chosen by themselves, rather than selected by a healthcare professional (Funnell & Anderson, 2004; Rossi et al., 2015; Wildevuur & Simonse, 2015). A traditional disease-centered care model is unlikely to encourage diabetes self-management, and without self-management, there is a risk that complications and deaths from diabetes will increase (Guariguata et al., 2014).

Patient-Centered Model

People with one or more chronic diseases face a need to make many changes in their daily lives. They require knowledge about each chronic disease and its treatment options, and they must adjust to consequential lifestyle changes. Such changes in behavior often conflict with patients' habits (Aujoulat et al., 2007; Rossi et al., 2015), which can lead to powerlessness in facing such challenges. A patient-centered model, which centers healthcare practice on the quality of patient care, presents an alternative to the disease-centered model (Epstein, Alper, & Quill, 2004; Epstein & Street, 2011). In such a model, the terms *patient-centered, personalized, and individualized* are interchangeable.

The Institute of Medicine has defined patient-centered care as “providing care that is respectful of and responsive to individual patient preferences, needs, and values and ensuring that patient values guide all clinical decisions” (Committee on Quality of Health Care in America, 2001, p. 40). Patient-centered care focuses on patients’ experiences of illness in such a way that the healthcare system can meet each person’s needs. Such a patient-centered model is based on the inherent need to respect patients as living beings (Epstein & Street, 2011). Healthcare professionals have the obligation to care for their patients by listening to them, informing and respecting them, addressing them as persons rather than mere cases, emphasizing their personal needs, and helping them become actively involved in their own care (Epstein & Street, 2011). A primary philosophical goal of the patient-centered model is to prioritize patients’ preferences and to build a partnership between patients and healthcare professionals (Anderson & Funnell, 2002; Aujoulat et al., 2007).

According to the National Institute for Health and Care Excellence (NICE), patient-centered care provides best-practice advice for management of diabetes, not only because the care is given by diabetes specialists, but because the advice is given within a framework that prioritizes patients’ needs and preferences so that patients have the opportunity to make decisions about their diabetes care and treatment (Sibal & Home, 2009). NICE recommends a patient-centered education model to meet individual needs and deliver quality-assured education (Sibal & Home, 2009). Non-pharmacological lifestyle management includes advice for high-fiber, low-carbohydrate, low-fat diets; physical activities; and glucose control by monitoring blood glucose and A1C. Pharmacological management includes insulin, oral hypoglycemic medications, and medications for blood pressure and blood lipid control (Sibal & Home, 2009).

Current diabetes care standards also include recommendations for patient-centeredness to improve diabetes care (ADA, 2015), specifically: a patient-centered communication style that incorporates patient preferences, along with a comprehensive plan to decrease cardiovascular risk through lowered blood pressure and hyperlipidemia, smoking cessation, weight reduction, and lifestyle changes for healthy diet, physical activities, and coping skills. Disease self-management includes taking medications, self-monitoring of blood glucose and blood pressure, prevention of diabetes complications through foot self-care, regular checking of the eyes, feet, and kidneys, and psychosocial care. The ADA states that psychosocial care is an ongoing concern for patients with diabetes, because psychosocial issues affect the abilities of patients and their families to carry out daily tasks (Young-Hyman et al., 2016).

Thus, the shift from a disease-centered model to the patient-centered model empowers patients with diabetes to improve their interactions with healthcare providers, access to the healthcare system, quality of life, and health outcomes. The HIW framework addresses patient-centered approaches, and mHealth can improve patients' interactions with healthcare providers and access to health information and the healthcare system.

THEORETICAL FOUNDATION

The Health Information Wants (HIW) Framework

The HIW framework, driven by grounded theory, focuses on the concept of HIW, that is, "health information that one would like to have and use to make important health decisions that may or may not be directly related to diagnosis or standard treatment" (Xie, 2009, p. 510). This framework describes preferences for information and decision-making autonomy.

Patient-centered care requires an understanding of the patient's preferences for health information and decision-making autonomy. As a patient-centered care model, the HIW framework provides a new approach to explain preferences for participation in decision making and a new perspective on how patients' health information wants may differ from what healthcare providers think patients need. It promotes an understanding of the patient's preferences from the patient's perspective rather than the healthcare provider's (Xie, 2009; Xie et al., 2015).

The HIWQ measures preferences for seven types of health information and decision-making, and items on the health information dimension were designed to parallel those on the decision-making dimension (each item on the information scale has a corresponding item on the decision-making scale). This allows direct comparison of preferences for participation in different types of health information seeking and decision making (Xie, 2009; Xie et al., 2011). The HIWQ has been validated in older and younger Americans (Xie, 2009; Xie, Wang, Feldman, & Zhou, 2010, 2013, 2014), as well as Chinese cancer patients and their family caregivers (Xie et al., 2015), showing excellent validity and reliability.

mHealth in Society

eHealth consists of "health services and information delivered or enhanced through the Internet and related technologies" (Eysenbach, 2001). mHealth is one aspect of eHealth: the "use of mobile phones and other wireless technology in medical care" (Rouse, 2016). mHealth includes medical and public health practices supported by mobile devices, such as mobile phones, patient monitoring devices, personal digital assistants, and other wireless devices (Adibi, 2015). mHealth devices collect clinical health data; share healthcare information among healthcare providers, researchers, and patients; and promote real-time monitoring and direct provision of care (Germanakos, Mourlas, & Samaras, 2005). The smartphone is the most popular and attractive device in mHealth (Lee, 2016). Indeed the mHealth market has grown rapidly since the smartphone's emergence (Lee, 2016).

According to the Pew Global Attitudes Project (2011), which surveyed 21 countries, 75% of the populations of those countries used text messaging, 93% of the

Chinese population owned cellphones, and 80% of those with cellphones in China used text messages. In 2016, 98% of Chinese owned at least a basic mobile phone, 68% owned a smartphone, 71% used the Internet at least occasionally, and 60% used social media (Pew Research Center, 2017). One study in the U.S. has shown that people with a chronic disease who have Internet access are more likely to use the Internet to find health-related information than users who do not have a chronic disease (Fox & Purcell, 2010).

mHealth and Empowerment

How can mHealth empower patients? Patient empowerment is a process to help patients control the risks that affect their health. An empowered patient is educated to think critically, make informed decisions, and adjust to prescribed care plans (Calvillo et al., 2013). Smartphones offer ease of use, accessibility, mobility, and connectivity, and healthcare providers and patients of course are mobile themselves (Lee, 2016). Healthcare is shifting to patient-centered care as patient satisfaction, empowerment, and engagement are becoming more important. The new healthcare paradigm encourages patients to access their medical data wherever they are, to discuss such data with their physicians, and to learn about their discharge plans (Hartin et al, 2016).

Mobile devices can be used in a number of ways to drive positive patient experiences (Kart, 2016). Patients can, for example, access their personal information and electronic health records and schedule doctor's appointments through their mobile devices (Kart, 2016); they can use physical activity monitors (e.g., Fitbit) to track their walking steps, distance walked, calories burned, and even sleep cycle (Shetty & Hus, 2016); and they can monitor their nutrition and glucose. The ability to share data wirelessly holds promise for a new way to manage diabetes (Kart, 2016; Hartin et al., 2016; Zhou et al., 2016), to change patients' health behaviors, improve health outcomes, and lower healthcare costs (Kart, 2016; Hartin et al., 2016; Lee, 2016). One of the greatest benefits of mHealth is that it can incorporate online education, it can extend diabetes self-management by connecting patients with healthcare providers, and it can allow care to reach beyond the physician's office by linking patients and physicians (Calvillo et al., 2013; Hartin et al., 2016; Lee, 2016; Zhou et al, 2016).

Given increased use of smartphones, a majority of patients with smartphones have reported using mobile apps for their health needs, ranging from searching for health and wellness information to managing their disease through remote monitoring (Riaz & Atreja, 2016). Therefore the combination of constantly accessible, highly interactive, and individually tailored feedback provides a great opportunity to encourage patients' behavioral changes and facilitate their maintenance (Hartin et al., 2016; Zhou et al., 2016). A randomized control trial study of mobile apps usage and clinical outcomes (Hartin et al., 2016) has shown that increased app exposure had an effect on various clinical measurements, in particular on body mass index (BMI) and systolic blood pressure (Hartin et al., 2016). Notably, those who used the app more than 7 times per week had the greatest reduction in BMI and blood pressure.

Researchers have begun to examine the use of mHealth for empowerment and improvement in outcomes (Calvillo et al., 2013; Hartin et al., 2016; Kart, 2016). Smartphone-based diabetes self-management has shown statistically significant improvements among Chinese patients with diabetes in their A1C levels, blood glucose levels, satisfaction, diabetes knowledge, and self-management behaviors (Zhou et al., 2016).

Quality of mHealth Information.

Mobile apps can assist with disease management and promote health awareness and well-being. However, the quality of health information available on the Internet and in mobile apps is questionable (Antheunis et al., 2013; Eysenbach et al., 2002; Zhang, Sun, & Xie, 2015). In a recent study, 45% of participants were concerned about the credibility or limitations of health information obtained online (Silver, 2015), and most online websites do not supply adequate health information for patients with diabetes (Eysenbach et al., 2002; Smart & Burling, 2001; Weymann, Härter, & Dirmaier, 2015). Weymann et al. (2015), who assessed the quality of health information on websites for diabetes patients' decision-making, found that only 49.6% of websites met criteria, and 13.6% of websites with information for patients with diabetes were at risk of not meeting patients' needs.

Studies have also indicated patients' concerns about unreliability of the health information provided on social media (Antheunis et al., 2013; Eysenbach et al., 2002).

Web-based health information does offer an opportunity to reach more patients at less cost and to empower patients in their communications with healthcare providers (Starcevic & Berle, 2013; Weymann, et al. 2013). But misinformation or incomplete information can have negative consequences, including increased anxiety, excessive use of the Internet to search for health-related information, and increased depression (Silver, 2015; Starcevic & Berle, 2013). Unintended consequences of misinformation include consumers' frustration and dissatisfaction (Eysenbach, 2014). Currently, however, there is a lack of knowledge about the quality of information available on diabetes-related Chinese websites and mobile apps.

Given the profound social and economic burdens imposed by diabetes in China, as well as the prevalent use of mobile devices, studies of ways in which mHealth can be used by Chinese patients with T2DM and how it might facilitate Chinese patients' self-management of their health conditions are needed.

STUDY AIMS AND RESEARCH QUESTIONS

There is growing evidence that patient-centered care will lead to empowerment for diabetes self-management, but if healthcare services are not personalized according to patients' needs and preferences, patients cannot be empowered. Patient-centered care is respectful and responsive to individual patients' preferences and needs (Rossi et al., 2015). The HIW framework, a patient-centered care model, measures preferences for seven types of health information and decision-making (Xie, 2009; Xie et al., 2013). The first aim of this study (Aim 1) is to explore individual preferences for types and amounts of health information and decision-making autonomy in Chinese patients with T2DM. The research questions (RQs) associated with Aim 1 are:

RQ1.1: What types and amounts of health information and decision-making autonomy do Chinese patients with T2DM want?

RQ1.2: What is the relationship between preferences for health information and decision-making autonomy in Chinese patients with T2DM?

RQ1.3: What individual factors (e.g., demographics, years been diagnosed with diabetes) are associated with the types and amounts of health information and decision-making autonomy that Chinese patients with T2DM want?

RQ1.4: What is the relationship between subscales for health information preferences and decision-making in Chinese patients with T2DM?

mHealth offers a cost-effective strategy to improve healthcare while advancing patient and health services (Buhi et al., 2012). The evidence shows that patients use mobile apps for numerous health needs such as gathering of health information, maintaining wellness, and managing diseases through remote monitoring (Riaz et al., 2016). The high adoption rate of mobile phones in China (mobiThinking, 2014) suggests that mHealth offers an opportunity to improve health behaviors among Chinese patients with diabetes (Zhou et al., 2016). Aim 2 of this study is to explore how mHealth might be used by Chinese patients with T2DM. The RQs associated with Aim 2 are:

RQ2.1: What is the frequency of Chinese patients with T2DM using a smartphone to access the Internet?

RQ2.2: What percentage of Chinese patients with T2DM uses smartphones to look for health-related information?

RQ2.3: What are the types and amounts of health-related apps in the smartphones of Chinese patients with T2DM?

RQ2.4: What individual factors (e.g., demographic, years been diagnosed with diabetes) are associated with smartphone use frequency in Chinese patients with T2DM?

RQ2.5: What individual factors (e.g., demographic, years been diagnosed with diabetes) are associated with the use of smartphones to look for health or medical information in Chinese patients with T2DM?

Frequent Internet users preferred significantly more information and decision-making than infrequent Internet users did (Xie et al., 2013). Aim 3 of this study is to explore the relationship between mHealth use and preferences for types and amounts of health information and participation in decision-making in Chinese patients with T2DM. The RQs associated with Aim 3 are:

RQ3.1: What is the relationship between smartphone use frequency and information and decision-making preferences?

RQ3.2: What is the relationship between the overall health information wanted and the use of a smartphone to receive health-related posts via smartphone-based social networking apps?

DEFINITIONS AND TERMS

Chinese patient with T2DM: A person born in China who has grown up there and continues to reside there. Patients must be at least 18 years old and diagnosed with T2DM by a Chinese endocrinologist (as reported by the patient and confirmed by the Chinese endocrinologist).

Diabetes diagnosis: Diabetes diagnosis based on A1C or on plasma glucose, either fasting plasma glucose (FPG) or 2-hour plasma glucose after a 75-gram oral glucose tolerance test (ADA, 2015).

T2DM treatment: Treatment goals are to control blood glucose levels and prevent diabetes complications, for example by modifying nutrition (healthy diet to fit personal lifestyle), engaging in physical activities, adhering to medications, and making personal lifestyle changes to prevent heart disease and high blood pressure (ADA, 2015).

Complementary and alternative medicine (CAM): A diverse set of medical and healthcare systems, practices, and products not generally considered part of conventional Western medicine (Long, 2011). CAM includes but is not limited to herbal supplements, meditation, chiropractic care, and acupuncture (Long, 2011). Along with disease prevention and health promotion, CAM contributes healthcare services; it can supplement, but not substitute for, standard treatments (Hawk, Ndetan, & Evans, 2012). Cartweight and Torr (2005) have indicated that CAM can relieve symptoms by enabling patients to gain energy and relax; it can also facilitate coping, and increase self-awareness. Hawk et al. (2012), in a secondary analysis of data from the 2007 United States National States National Health Interview Survey, found that 8.4% of American adults used chiropractic or osteopathic manipulation, 8.1% used massage, and over half (55.7%) of those who used CAM therapies did so for disease prevention and health promotion; 18.0% of these patients had hypertension; 19.6%, high cholesterol; 9.1%, prediabetes or diabetes; 54.2% were overweight or obese; 22.0% were physically inactive; and 17.4% were smokers.

Various types of CAM—Tai Chi, Qigong, traditional Chinese medicine, and acupuncture—are used in China to promote general health and prevent medical issues (H. Hu, Li, Duan, & Arao, 2013). From 2002 to 2005, the prevalence of CAM use in China was 40%, and use was especially high in people with hypertension (H. Hu et al., 2013).

WeChat: WeChat is a social media application developed by Tencent which is one the largest Internet companies in China (Tencent offers many services, including social networking, web portals, e-commerce, mobile games, and multiplayer online games). WeChat is a messaging and calling app that allows people to easily connect with family and friends across countries. It is an all-in-one communications app for text, voice and video calls, photo sharing, games, and much more (What Is WeChat? 2017).

QQ: Tencent QQ is a widely used instant messaging web portal in mainland China. It offers a variety of services, including online social games, music, shopping, microblogging, movies, group and voice chat, etc. (Jodel, 2011).

SUMMARY

China has the highest prevalence and burden of diabetes in the world, and Chinese patients need up-to-date knowledge and skills to support informed decision-making and self-management based on established evidence-based standards (Haas et al., 2013; Paulweber et al., 2010). Empowering patients in diabetes self-management is critical. Diabetes is a chronic disease that requires extensive and continuous attention and management. mHealth can be a cost-effective approach to support effective diabetes self-management and promote diabetes health awareness and well-being by empowering decision-making. However, Chinese patients do not receive sufficient diabetes-related information from their healthcare providers, resulting in severe health consequences and a sense of powerlessness regarding medical treatment and self-management.

Evidence indicates that existing Chinese diabetes apps lack comprehensive features and a sufficiently diverse range of information based on patients' preferences for information topics and formatting (Nie et al., 2016). If healthcare services are not personalized according to patients' needs and preferences, patients will not be empowered, and their quality of life and health outcomes will not be improved.

The HIW theoretical framework presents a patient-centered care model that explains patients' preferences for health information and decision making so that they can better participate in their health care (Xie, 2009; Xie et al., 2014). The HIW framework offers a new approach for examining preferences for types and amounts of information and participation in autonomous decision making; it measures the types and amounts of health information patients would like to have in order to make decisions that may or may not be associated with their diagnosis and standard treatment (Xie, 2009). This perspective may differ from what healthcare providers think their patients require and promotes a new way to understand patients' preferences from the patient's perspective (Xie et al., 2015).

This study is ultimately intended to provide a validated Chinese-language instrument for examining information and decision-making preferences; to provide examples for mHealth developers to design diabetes information tailored to the general public; and to provide strong empirical support for the HIW theoretical framework that will promote a patient-centered approach to patients' preferences.

CHAPTER 2: REVIEW OF THE LITERATURE

To examine the research on preferences for health information and decision-making autonomy among Chinese patients with T2DM within the context of mHealth for diabetes self-management, four key areas of the literature were reviewed: (a) Chinese patients with T2DM and their unique nutritional culture; (b) the effectiveness of mHealth-based diabetes self-management interventions in improving behavioral adherence and health outcomes; (c) existing Chinese mobile apps for Chinese patients with T2DM; and (d) preferences for information and decision-making autonomy and their impact on diabetes self-management.

TYPE 2 DIABETES IN CHINA

T2DM

For this review, diabetes is defined as a self-reported diagnosis by a healthcare provider; fasting plasma glucose level of 126 mg/dl or higher; 2-hour plasma glucose level of 200mg/dl or higher; and A1C of 6.5% or higher (ADA, 2015). T2DM develops when the body becomes resistant to insulin or when the pancreas stops producing enough insulin (ADA, 2015; Haas et al., 2013). Common risk factors for T2DM are being overweight, unhealthy diet, physical inactivity, and increasing age (Guariguata et al., 2014; Hassan et al., 2014; Hernandez-Tejada et al., 2012).

Since the 1980s China has had one of the world's fastest growing economies (S. Li et al., 2015). As the largest developing country in the world, China has shown the greatest increase in the prevalence of diabetes over the last two decades (Zuo, Shi, & Hussain, 2014) and also the greatest increase in people being overweight and obese (Chan et al., 2009). In 1980, China's diabetes prevalence was at its lowest rate of less than 1% (H. Xu et al., 2010); this increased to 2.5% in 1994, 5.5% in 2001 (M. Li et al., 2013), and 9.7% in 2007 (W. Yang et al., 2010). The prevalence rates for diabetes are statistically higher in urban areas in China than in rural areas (H. Li et al., 2012). More than 92 million Chinese adults have diabetes, and 248 million have prediabetes (F.B. Hu, 2011). The high prevalence of diabetes in China is undoubtedly due to rapid social and economic development, excessive caloric intake, and inadequate physical activities, along with the aging of the population (Scheibe et al., 2015; Zhao, Zhao, Li, & Zheng, 2012), and rapid urbanization (Guariguata et al., 2014).

Risk Factors

Contributing factors for T2DM in China are fast economic development, urbanization, and transitions in nutritional status (F. B. Hu, 2011). Chinese people consume a large quantity of rice-based products (Villegas et al., 2007), which present a greater risk for T2DM due to their high glycemic index and glycemic load (H. Xu et al., 2010; Villegas et al., 2007). Also because of rapid economic and social development, traditional food patterns are being replaced as the Chinese people adapt to more industrial and urban dietary environments (F. B. Hu, 2011), as well as Western fast foods (Levine, 2008; Patterson, 2011). All of these changes, with resulting increases in weight and obesity, can contribute significantly to T2DM risk.

The rates of obesity and being overweight are still relatively low in Asia in comparison with the West (Y. Xu et al., 2013), but they are increasing (F. B. Hu, 2011; Patterson, 2011). The World Health Organization has reported that in 2005, 34% of men and 30% of women in China were overweight, but in 2015, these percentages had increased to 57% for men and 46% for women.

Evidence indicates that increased physical activities decrease the risk of diabetes. In China, increased automobile transportation is related to decreased physical activities (Bell, Ge, & Popkin, 2002; F. B. Hu, 2011). According to Bell et al. (2002), the chances of becoming obese were 80% higher for people who owned a motorized vehicle as opposed to those who did not (14% of households bought a vehicle between 1989 and 1997). Cigarette smoking is yet another risk factor for T2DM. China is the largest producer of cigarettes, with the largest population of cigarette smokers (L. Yang, 2011). Heavy alcohol intake is also a risk factor for T2DM due to excessive caloric intake which can lead to becoming overweight and obese (Koppes, Dekker, Hendriks, Bouter, & Heinem, 2005). With rapid globalization and socioeconomic development, social marketing continues to attract more Chinese people to adopt Westernized lifestyles with heavy drinking (F. B. Hu, 2011).

EFFECTIVENESS OF MHEALTH INTERVENTION FOR DIABETES SELF-MANAGEMENT

T2DM requires ongoing medical care and patient self-management (El-Gayar et al., 2013; Haas et al., 2013; van Vugt et al., 2013). For self-management to be effective, patients must have sufficient information regarding all aspects of their disease (Haas et al., 2013). Diabetes self-management requires that patients have necessary and sufficient knowledge, skills, and capabilities; and mobile technology provides a way for patients and their families to obtain this needed information (Sultan & Mohan, 2012). mHealth has brought advanced mobile communications and technologies to patients with diabetes (Martínez-Pérez, de la Torre-Díez, & López-Coronado, 2013; van Vugt et al., 2013). It allows patients and healthcare providers to collaborate in patients' glucose, weight, and diet control; it provides direct, immediate feedback to the patient (Goh et al., 2015; Lyles et al., 2011; Wildevuur & Simonse, 2015); and it may reduce hospitalizations, readmissions, and healthcare costs (Wildevuur & Simonse, 2015). Mobile platforms can provide an open environment in which to discover necessary information, enabling patients to record, review, and share their health status. Remote platforms also allow patients to receive direct instructions or coaching from their healthcare providers (Goh et al., 2015; Sultan & Mohan, 2012).

Mobile apps can assist diabetes self-management with healthy diets, physical activities, and blood glucose monitoring (El-Gayar et al., 2013; Goh et al., 2015). Mobile apps can be used to record fluid intake, calculate calories, and measure blood glucose and physical activities for the achievement of personal goals (Årsand, Tatara, Østengen, & Hartvigsen, 2010; Weymann, Dirmaier, Wolff, Kriston, & Härter, 2015). They can be used to improve lifestyles through smoking cessation, reduced alcohol intake, diet modification, and physical activities (Weymann, Dirmaier, et al., 2015).

In a systematic review, Buhi et al. (2012) showed that mobile phone interventions such as the use of short message services (SMS) yielded statistically significant results for lower blood glucose, weight loss, decreased BMI, and increased physical activities. A meta-analysis of the effect of mHealth intervention on glycemic control indicated a clinically significant reduction in A1C of 0.5% at 6-month follow-up (Liang et al., 2011). A randomized lifestyle weight loss clinical trial of a text message intervention in a Chinese sample showed clinically significant decreases in weight, waist circumference and body fat, and as well as improved blood pressure (Lin et al., 2014).

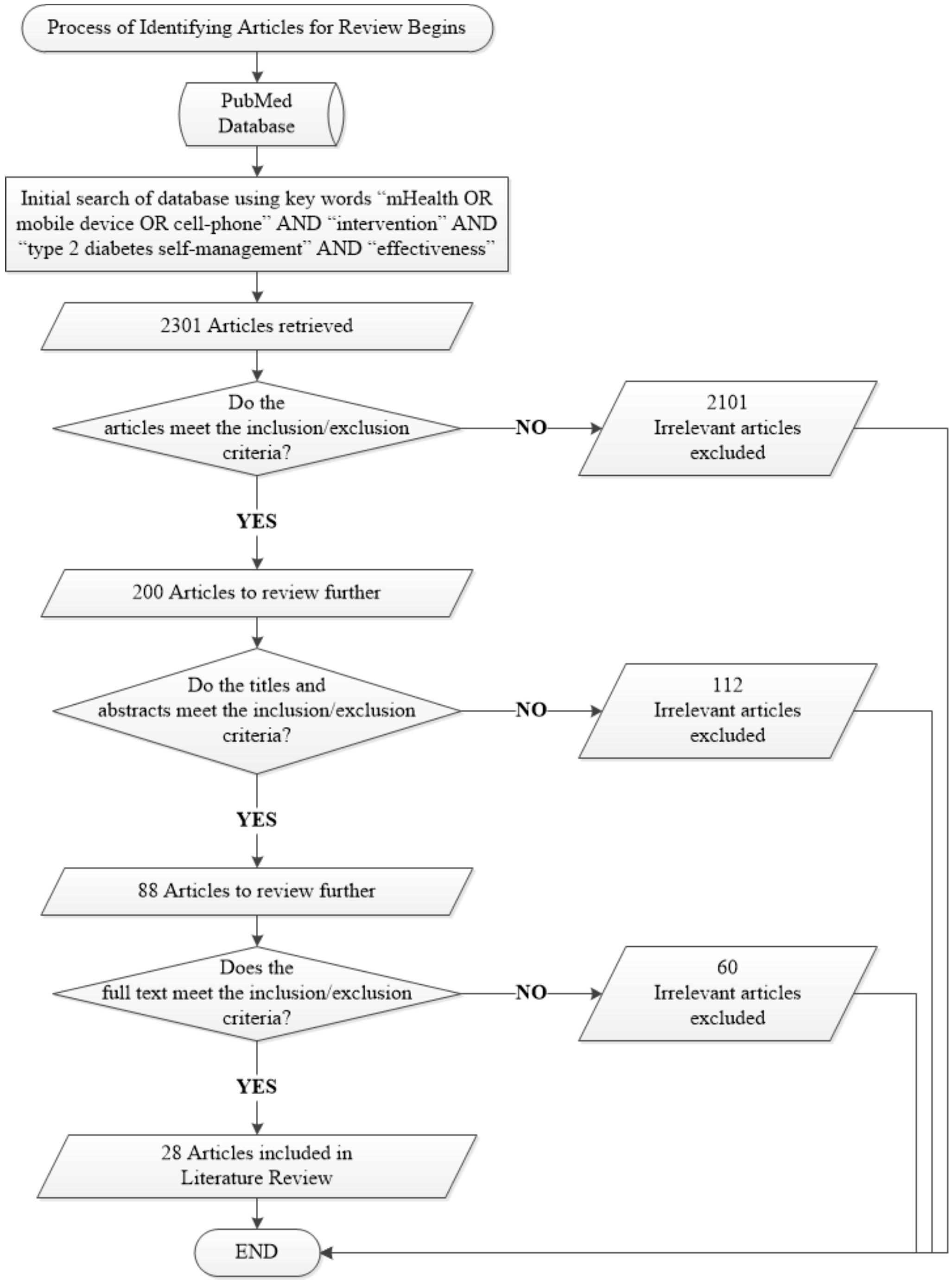
Previous systematic reviews have evaluated mHealth in terms of usability (Arnhold et al., 2014) and examined whether theory-based online self-management programs were effective in chronic disease management (Ribu et al., 2013). None has specifically focused on the effectiveness of mHealth interventions for diabetes self-management. To understand the effectiveness of mHealth-based diabetes self-management interventions in improving health outcomes and behavioral adherence, as well as the characteristics of diabetes mHealth in self-management interventions, it is important to start with a review of what the mHealth-based diabetes evidence shows. One must determine whether mHealth is improving health outcomes and behavioral adherence. For this purpose, we conducted a systematic review of studies published during the past 5 years (2011–2015), because mHealth technologies have advanced and expanded rapidly during that period, and it is necessary to focus on the most recent technological advancements.

In January 2016, we performed a systematic search in PubMed database using the following search key words or phrases “mHealth OR mobile device OR cell-phone” AND “intervention” AND “type 2 diabetes self-management” AND “effectiveness.” Inclusion and exclusion criteria were used for title and abstract screening, as well as for the full text review. The inclusion criteria were as follows: (a) adults diagnosed with T2DM; (b) full text written in English and published during 2011–2015; (c) mHealth interventions designed for diabetes self-management; and (d) physiological outcomes (A1C, blood glucose, blood pressure, lipids, or weight), adherence to self-management behaviors (diet, physical activities, medications, blood glucose self-monitoring, appointment keeping), or quality of life.

Data were extracted from the selected articles using predetermined criteria, according to two major categories: (a) characteristics of the study (country in which the study was conducted, study setting and design, purpose of the study, sample size and mean age of participants, and mobile device employed and mobile technology functions used); and (b) characteristics of the mHealth diabetes self-management intervention (the description of the intervention, whether a control group was used, timing of outcome assessment and specific outcomes that were assessed, including physiologic outcomes and targeted behavioral adherence/psychosocial factors). Physiological outcomes included were glycosylated hemoglobin (A1C), blood glucose, blood pressure, lipids, and weight (Brown et al., 2015). Behavioral adherence factors included adherence to diet, physical activities, medications, glucose self-monitoring, follow-up appointments; psychosocial factors included stress, depression, anxiety, and coping (Brown et al., 2015).

Because mobile technology users tend to be younger and the population diagnosed with T2DM tends to be older, mixed T1DM and T2DM studies were excluded, because such a wide age range and both diagnoses might confound intervention effects. After screening, 28 studies met the inclusion criteria and served as the final sample for this review. These search and selection steps are illustrated in Figure 2 below.

Figure 2: Process of Identifying Articles for Review



Characteristics of mHealth Studies in T2DM Self-Management

All studies were published during 2011–2015, with 2015 seeing the highest number (10 studies), followed by 2014 and 2013 with 7 studies each; only 2 studies were published in 2012 and also in 2011. The overall sample size across studies was 2,931, and the study completion rate was 88% (N = 2,578). The average age of study participants across the 28 studies was 57.2 years (range: 18 to 75), and the average intervention duration was 6.8 months. Fourteen of the 28 studies set A1C inclusion criteria between 6.5% and 11% (Arora, Peters, Burner, Lam, & Menchine, 2014; Capozza et al., 2015; Cherrington et al., 2015; Karhula et al., 2015; Khanna et al., 2014; Lim et al., 2015; Lyles et al., 2011; Nagrebetsky et al., 2013; Orsama et al., 2013; Osborn, Mulvaney, & Shelagh, 2013; Quinnet et al., 2011; Ribu et al., 2013; Wayne, Perez, Kaplan, & Ritvo, 2015; Williams et al., 2012). Three studies included individuals with more than one chronic condition: T2DM and chronic obstruction pulmonary disease (Weegen et al., 2015); T2DM and heart disease (Karhula et al., 2015); and T2DM, irritable bowel syndrome, and chronic widespread pain (Nes, Eide, Kristjánsdóttir, & van Dulmen, 2013). The included studies reflected a wide variety of nationalities (United States, Canada, Europe, Australia, Korea, Japan, Singapore, Iraq). These studies' characteristics are summarized in Table 1 below.

Table 1: Characteristics of mHealth Studies in Diabetes Self-Management – T2DM

References Nationality; setting	Purpose of study	Study design	Sample /Mean Age	Mobile device employed	Mobile technology functions used
Verwey, et al. (2015) Europe 24 family practices	To evaluate of the It's LiFe RCT process and examine the reach, implementation and satisfaction with the counselling protocol and the tool.	3-arm cluster RCT	N (PTs): 109/131 T2DM & COPD N (Nurses): 19/20 Mean age: 58	Smartphone, Web app: a monitoring and feedback tool on PA	PT received SM via lifestyle feedback in real time PA results and HX in minimum or moderate to vigorous PA on m-phone and Web app in relation to an activity goal, automatic dialogue with nurse.
Weegen, et al. (2015) Europe 24 family practices	To evaluate 1) whether SSP (self-management support program) combined with use of monitoring and feedback leads to more PA compared to usual care, and 2) additional effect of using tool on top of SSP.				
Wayne, et al. (2015) Canada Primary care lower –SES (90%)	To evaluate the effectiveness of a health coach (HC) interv with and without the use of mobile phones to support health behavior change in pts with T2DM in lower-SES	Noninferiority, pragmatic RCT	N: 131/138 A1C > or equal 7.3%) Mean age: 53.2 (11.3)	NexJ Systems Inc, mobile phone software for logging health data	tracking: BG, PA, diet, mood- transmission of reminder messages encouraging activation and adherence. Real-time feedback immediately.
Pludwinski, et al. (2015) Canada Community health centre lower-SES	To investigate experience of T2DM participated in intervention of a Smartphone and self-monitoring software. To compare effectiveness of 6mons smartphone use with HC vs HC without smartphone support.	RCT: qualitative evaluation	N: 11 Mean age: M-64(4.9); F-55.8(8.8)	NexJ Systems Inc, mobile phone software for logging health data	PA and food tracking, HC communication, self-generated/coach-generated reminders.
Lim, et al. (2015) Korea Outpatient clinic	To test effect of an individualized multidisciplinary u-healthcare service system (CDSS) combined with PA and dietary feedback on BG control with less hypoglycemia in an older population	Block of RCT	N:100/121 A1C: 7.0-10.5% (53.0) Mean age: 64.3(5.2)	Public switched telephone network (PSTN) – connected glucometer to measure BG	BG, PA, dietary selection are, transferred to main server, tailored messages automatically generated from CDSS rule engine to mobile phone.
Capozza, et al. (2015) USA Community-based , primary care clinics	To assess feasibility of deploying a novel 2-ways text-message Ed and behavioral support program, to test effectiveness of program in improving glycemic control T2DM patients, and to examine PT interaction and satisfaction with program	2-arms RCT	N:93 A1C > 8% Mean age: 54.5 (10.7)	Care4Life: text message program: 6 messages protocols & core educational message stream	Meds reminder & adherence; BG testing reminder, prompts results; BG reminder, feedback; tracking & encouraging self-entered WT loss, PA goals with weekly prompts.

Table 1 continue

References Nationality; setting	Purpose of study	Study design	Sample /Mean Age	Mobile device employed	Mobile technology functions used
Goh, et al. (2015) Singapore 18 public primary care polyclinics	To assess iDAT (interactive diet and activity tracker) app usage in pts with T2DM; to better understand and characterize the nature and extent of technological engagement with a caloric-monitoring mobile health app, iDAT by T2DM PTs.	Quantitative descriptive study: (logistic regression)	N=84 (no inform on drop out) Mean age: 48.2 (8.5)	iDAT app: a caloric-monitoring mobile health app - food intake and PA.	Smartphone app.: calorie counter: users to balance calories consumed with calories burned on a daily basis (food consumed, workout estimated calories burned
Quinn, et al. (2015) USA	To evaluate participant self-efficacy and use of a mobile phone DM health intervention for older adults during a 4 weeks period.	Pilot study	N: 7 (no drop out) Mean age: 70.3	PCS (PT-Coached System): mobile communication software	PCS sends automated messages to provide feedback on DM self-care: BG, diet, meds, PA, DM management inform based on users entered data.
Cherrington, et al. (2015) USA Community outreach AA population	To develop an effective model for integration of a community-based CHW (community health worker) program with primary care-based efforts to improve DM health outcomes via mHealth technology.	Pilot study	N: 70/ 72; A1C > 7.5%; Mean age: Pts: 54.9 (9.1);	Diabetes Connect Web app.	Contact tracking and call reminder, secure communication, and progress reports system. Allow patient ask questions and seeking support in real time
Aikens, et al. (2015) USA VA outpatient clinics.	To test hypothesis that interv yields long-term in functional status, depressive symptoms, DM-related distress increases, improves 3 SM behaviors: Meds adherence, SMBG, checking one's feet for tissue damage and frequency of high and low BG values by SMBG	Observational open label trial	N: 261/301 Mean age: 66.7(9.8)	IVR: interactive voice response.	Weekly IVR calls to provide real-time problem-tailored support; team will be notified when sig difficulties and will provide a automatic, structured updates to PT and caregivers from outside pt's home with guidance on SM support.
Karhula, et al (2015) Finland Primary and secondary health care district	To study whether a structured mobile phone-based coaching program, which was supported by a remote monitoring system, could be used to improve the health-related quality of life (HRQL) and /or the clinical measures of T2DM and heart disease patients	RCT	225/250 DM 246/267 Heart PTs A1C >6.5%; MEAN AGE: 66.6 (8.2)	Mobile phone with PHR app which connecting to a BP meter	Wt, BG, BP measured will be transferred to PHR using a binary SMS text message. Health coaches and PTs can see PTs' measurements in PHR, advised given during HC.
Aikens, et al. (2014) USA VA outpatient clinics.	To characterize DM PT engagement and clinician notifications for an IVR service: monitor PTs' symptoms & SM problems, provide tailored messages about DM SM & medical help-seeking, generate guidance on SM support via structure emails, provide clinicians' feedback to PTs.	Observational study	N: 303 (108 in 3 mons, 195 in 6 mons; no drop out data). Mean age: 66.6 (9.8)	IVR: interactive Voice response	Weekly automated IVR monitoring and self-care support: SMBG, med and dietary adherence, BG, BP, foot inspection, and overall functioning.

Table 1 continue

References Nationality; setting	Purpose of study	Study design	Sample /Mean Age	Mobile device employed	Mobile technology functions used
Haddad, et al. (2014) Iraq Teaching hospital clinic	To evaluate feasibility and utility of short message services (SMSs) to support Iraqi adults with newly diagnosed T2DM.	A feasibility study	N: 42/50 Mean age: 51.4 (10.3)	SMSs: mobile phone	1 text message sent weekly to each PT using website at same time: reminders about diet, TX, complication awareness, BG, enhancement of clinic attendance.
Khanna, et al. (2014) USA Federal qualified health center low SES	To determine if automated telephone nutrition support (ATNS) counseling could help PTs improve BG by duplicating a successful pilot in Mexico in a Spanish-speaking population.	Prospective RCT open-label trial	N:75, in Spanish speaking A1C: >8.5% Mean age: 52(12)	ATNS, computerized system that users on their phone, prompted in Spanish.	24 hours of various cultural-specific dietary items and provided dietary feedback based on proportion of high vs low glycemia index foods consumed
Arora, et al. (2014) USA Urban, public ED	Low-income inner-city PTs with DM utilize ER for acute & chronic care. To determine whether a scalable, low-cost, unidirectional, text message-based mHealth interv (TExT-MED) improves clinical outcomes, increases healthy behaviors, and decreased ER utilization in a safety net population	RCT	N: 92/128 A1C: equal or > 8% Mean age: 51 (10.2)	TExT-MED	Fully automated, text message-based program: 2X daily text messages; ED/ motivation message, med reminders, trivia questions, healthy living challenges.
Waki, et al. (2014) Japan. University Tokyo hospital	To develop a real-time, partially automated interactive system to interpret pts' data - biological information, PA, diet content calculated from a message sent by pts - and respond with appropriate actionable findings, helping pts achieve DM self-management.	Nonblinded, RCT study. .	54 (no drop out). Mean age: 57.1 (10.2)	DialBetics:	Automated data transmission, evaluation, and communicate with pts on dietary and PA, speech-recognition device.
Burner, et al. (2014) USA Low-income Latino population, 92% uninsured.	To examine nuances of motivation, intention, triggers to action effected by TExT-MED (Trial to Examine Text Messaging for Emergency Department PT with DM), an mHealth intervention tailored to low-income, urban Latinos with DM.	Qualitative study	N: 24 (5 focus grps) Mean age: 53 (10.25)	TExT_MED: for low-income Latinos	Fully automated, text message-based program: 2X daily text messages; ED/ motivation message, med reminders, trivia questions, healthy living challenges.
Nagrebetsky, et al. (2013) UK Primary care.	To explore feasibility of stepwise self-titration of oral glucose-lowering meds guided by a mobile telephone-based telehealth platform for improving glycemic control in T2DM.	RCT feasibility study	N: 14 A1C : 8-11%. Mean age 58 (11)	Self-monitored blood glucose (SMBG) with tele support (MATS).	BG transmitted from meter to mobile phone, then loaded to central server via mobile 3G network. A m-phone diary app in pt’s phone to give real-time graphic feedback on BG.

Table 1 continue

References Nationality; setting	Purpose of study	Study design	Sample /Mean Age	Mobile device employed	Mobile technology functions used
Ribu, et al. (2013) Protoocol study Norway Southern and northern parts, some from local public health clinics.		3-armed prospective RCT and qualitative interviews	N: 120/ 151 A1C 7.1% or greater. Mean age 57 (12).	FTA: Few Touch Application	5 main elements data management to user: BG, food habits, PA, personal goal-setting, general DM information look-up system. BG transferred from BG meter automatically to m-phone-based DM diary, PA, food habits entered manually by the user, user sets personal goals for PA, food habits. visual graphs, trend reports, feedback via color coding
Torbiomsen, (2014) (4 mons study)	To evaluate whether introduction of technology-supported SM using the FTA DM diary with or without HC improved A1c, SM, behavior change, HRQOF; to describe sociodemographic, clinical and lifestyle characteristics of participants after 4 mos.	3-arm prospective RCT.			
Holmen, (2014) (12 mons study)	To test whether a m- phone-based SM system for 1 yr, with or without telephone HC by a DM specialist nurse for the 1st 4 mos, could improve HbA1c, SM, health-related QOL compared with usual care.	3-arm prospective RCT			
Lyles, et al. (2013) USA Low income San Francisco residents	To examine safety events and potential safety events in the context of a multilingual automated telephone SM support intervention within a diverse DM PT population	Quasi-experimental design	N: 278/362 Mean age: 55.9	HIT (health information technology): IVR – interactive voice response.	Weekly call: ED content on self-care, med adherence, safety concerns, psycho. Issues, preventive services. Users provided responses from their phone keypads.
Osborn, et al. (2013) USA	To design an engaging medication adherence promotion interventions for low-income pts with T2DM that can be delivered using readily available call phone technology.	A design and technical pilot /feasibility	20 (no drop out data). A1C 7.6% (1.8) Mean age: 51.6 (8.8).	SuperEgo, tailored text messaging. IVR (Interactive voice response) phone call.	1-way tailored text to address user's barriers & 2-way text msg to assess med adherence performance, a weekly IVR call to give feedback, reinforcing msg.
Nes, et al. (2013) Norway. Via general practitioners and social network	To develop and test feasibility of a 3 mos web-based intervention, a smartphone to support SM in pts with T2DM (has other two study together: irritable bowel syndrome and chronic widespread pain)	Descriptive study (a pilot feasibility study).	11/15 No mean age, no inclusion/exclusion criteria)	FTA: Few Touch. App.	Diaries in 16-19 questions chosen for supporting self-monitoring (BG, diet, Med, achieved activities) and awareness of health behavior, thoughts, feelings, applied SM strategies.

Table 1 continue

References Nationality; setting	Purpose of study	Study design	Sample /Mean Age	Mobile device employed	Mobile technology functions used
Orsama, et al. (2013) Finland Community health center	To develop and evaluate a mobile telephone-based remote patient reporting and automated telephone feedback system, guided by health behavior change theory, aimed at improving SM and health status in individuals with T2DM	RCT	N: 48/56 A1C > or equal 6.5% Mean age: 62.3(6.5)	"Monica" a mobile phone application	Graphs reflecting uploaded data to each target values (BG, BP, Wt, PA) and an information, motivation, behavioral skills feedback message to support PT self-care
Tatara, et al. (2013) Norway no data on study setting	To contribute toward accumulating knowledge about factors associated with usage and usability of a mobile SM app over time through a thorough analysis of multiple types of investigation on each of participant's engagement.	Longitudinal descriptive study (a pilot feasibility study	10/12 Mean age 55 (9.6).	FTA: Few Touch App, "Diabetes Diary" (DM diary)	Automatic data transmission from a BG meter to a step counter; nutrition habit recording on smartphone; feedback with simple analysis by DM diary; goal-setting; general tips for SM of DM.
Burner, et al. (2013) USA County hospital, 75% Latino	Focus grps to examine how TExT-MED (Trial to Examine Text Messaging for Emergency Department patients with DM) impacted DM SM.	Qualitative analysis of focus grps	N: 8 (2 focus grps) Mean age: ??	TExT-MED	Text message-based program: 2X daily text messages; ED/ motivation message, med reminders, trivia questions, healthy living challenges
Williams, et al. (2012) Australian. Primary care hospitals	To evaluate a TLC (Telephone linked care) program – the Australian TLC Diabetes program – designed to improve T2DM management.	2 arms prospective RCT	111/120 A1C > or equal 7.5%. Mean age: 57 (8.3).	TLC: automated interactive telephone system,	SM behaviors: BG, nutrition, PA, medication-taking. Feedback, encouragement, tailored information will be given.
Logan, et al. (2012) Canada Physicians' office, clinics	To compare effectiveness self-care msg on the smartphone of hypertensive DM PTs to home BP monitoring without self-care support. The psycho. effects of promoting PT self-care were examined.	RCT: prospective, open, blinded, no control group	N: 106/110 Mean age: 63(7.8)	BlackBerry smartphone paired with Bluetooth-enabled home BP monitoring device	BP readings auto- reporting & alerting self-care msg sent to screen of PT's smartphone in real-time; msg related to control of BP were tailored to PT's needs.
Quinn, et al (2011) USA Community primary care practice	To test whether adding mobile app coaching and PT/provider web portals to community primary care compared with standard DM management would reduce A1c levels in PTs with T2DM.	Cluster-RCT	N:163/213 A1C: equal or greater than 7.5% Mean age: 52.8	A mobile DM manage software app	Users enter data (BG, carbohydrate intake, meds, other DM manage information) in m-phone, receive automated, real-time tailored ED, behavioral, motivational msg to entered data.
Lyles, et al (2011) USA Outpatient clinic	To qualitatively evaluate the expanded DM management program among pts with T2DM via m-phones and a game console web browser.	Pilot study with qualitative interviews	N: 8 A1C: >7% Age: 18-75	Smartphone, mobile version 6.0 or higher.	From loaded values, users received a confirmation, then displayed a trend, graphs, tables, etc., to users in visual combining BG, carbohydrate intake, insulin dose, PA data.

Abbreviations:

AA	African American	Interv.	intervention	Sig.	significant
app	application	Mo	month	SM	self-management
BP	blood pressure	m-phone.	mobile phone	SMBG	self-monitoring of blood glucose
Cont.	control	msg	message	SMS	short message services
DM	diabetes	PA	physical activity	Stat.	statistically
ED	education	PHR	personal health record	TX	treatment
ER	emergency room	PT	patient	wks	weeks
grp	group	RCT	randomized controlled trial	Wt	weight
HCP	healthcare provider	SES	socio-economic status		
HX	history				

Our review found that mHealth interventions were described according to the mobile devices employed, mobile technology functions used, and purpose of each study. The interventions used smartphones as the mobile device with a wide variety of apps in the studies. The mobile apps had unique functions. All of the studies provided automated messages and real-time feedback. Some apps provided specific interventions, such as iDAT for calorie monitoring (Goh et al., 2015), ATNS for culture-specific dietary coaching (Khanna et al., 2014), and SuperEgo and IVR for medication adherence (Osborn et al. 2013).

Nine studies employed smartphones supporting self-management interventions. For example, the smartphone might be programmed to send automated text messages to provide tailored information and feedback in real time on diabetes self-management such as reminders, graphic feedback on progress, or safety alerts. (Haddad et al., 2014; Karhula et al., 2015; Logan et al., 2012; Lyles et al., 2011; Nagrebetsky et al., 2013; Quinn, Khokhar, Weed, Barr, & Gruber-Baldini, 2015; Quinn et al., 2011; Verwey, van der Weegen, Spreeuwenberg, Tange, van der Weijden, & de Witte, 2016; Williams et al.

2012). Two studies used an app from NexJ Health as a tracking and reminder device for BG, PA, and diet, which provided real-time feedback for encouraging activation and adherence to diabetes self-management behaviors. (Pludwinski, Ahmad, Wayne, & Ritvo, 2016; Wayne et al., 2015).

Three studies employed ExT-MED, a text-message-based mobile health intervention. Text messages were sent to patients daily, including messages related to diabetes information, questions aimed at motivating and/or challenging patients to make healthy living choices, and medication reminders (Arora et al., 2014; Burner, Menchine, Taylor, & Arora, 2013; Burner, Menchine, Kubicek, Robles, & Arora, 2014). Three other studies employed the Few Touch Application (FTA) as the intervention. The FTA is a smartphone-based diabetes diary app that can automatically transmit BG levels, footsteps taken, and nutrition habits to a remote server. The program's 16 to 19 questions can be chosen to support glucose self-monitoring, nutrition/diet adherence, accurate medication administration, and other self-management activities. The device also has a goal-setting feature (Nes et al. 2013; Ribu et al., 2013; Tatara, Årsand, Skrøvseth, & Hartvigsen, 2013).

The DiaBetics app can transmit and evaluate data, triggers alerts, and communicates with users (Waki et al. 2014). Three studies employed a mobile health interactive voice response (IVR) program, in which safety triggers assisted users with self-management between healthcare provider visits (Aikens, Rosland, & Piette, 2015; Aikens, Zivin, Trivedi, & Piette, 2014; Lyles et al., 2013).

Physiological Outcomes

Five key physiological outcomes (Table 2) are commonly used as indicators of diabetes status: A1C, blood glucose, blood pressure, lipids, and weight (Brown et al., 2015). These key indicators have been studied as valuable predictors of diabetes outcomes (Brown, 1988, 1992; Brown et al., 2015). As Table 2 shows, 15 of the 28 studies (54%) measured A1C as a physiological outcome. Eleven studies reported statistically significant decreases in A1C, either by comparing an intervention group with a control group or by comparing a single group's pre-intervention and post-intervention results (weighted A1C average = -0.84%) (Arora et al., 2014; Haddad et al., 2014; Lim et al., 2015; Nagrebetsky et al., 2013; Nes et al., 2013; Orsama et al., 2013; Pludwinski et al., 2016; Quinn et al., 2011; Waki et al., 2014; Wayne et al., 2015; Williams et al., 2012). Four studies reported no statistically significant change in A1C (Capozza et al., 2015; Karhula et al., 2015; Khanna et al., 2014; Ribu et al., 2013).

Table 2: Characteristics of mHealth Interventions in Diabetes Self-Management – T2DM

Reference / Control group	Intervention	Physiological outcomes	Behavior adherence /psychosocial	Results	Conclusion
Verwey, et al. (2015) Cont. usual care (grp 3)	Grp 1: SM support program and tool for 4-6 mons Grp 2: SM support program and without tool	None	PA: sig. positive; use tool led to greater awareness & importance of PA	PA: grp 1, PTs- stat. sig. +, p=.004; PA Effectiveness of program: b/t two grps; grp 1: 90% and grp 2: 56%. Sat: grp 1, nurses- stat. sig. p=.04. with SM support; very positive in sat. with tool.	Greater awareness of the importance of PA, PTs from both grps appreciated the focus on PA and personal attention given by the nurse. PTs with tool estimated more improvement of PA than pts without the tool.
Weegen, et al. (2015) Cont: usual care (grp 3)		PA: minutes per day	Self-efficacy (SE) in general and PA self-efficacy and QOL	PA: grp 1 to 3 p<.001, grp 1 to 2 p<.05; 3mos after interv; b/t grp 1 and 3: p<.001; b/t grp1 to 2: p<.001. No sig b/t grp 2, 3. No effect for PA SE, QOL higher in grp 1,2.	Combining counseling with tool proved an effective way to stimulate PA. Counseling without the tool wasn't effective.
Wayne, et al. (2015) Cont. no m-phone monitoring support	Interv grp: health coaching (HC) with m-phone monitoring support – 37 min/wk of interaction. Cont: without m-phone support - verbal discussion – 39 mins/wk of interaction	A1C, WT, waist, circ BMI	Both grps: positive in mood, sat with life, and QOL	A1C: b/t grps at 3 mos: p=0.03; 6 mos: p=0.48; Wt, p=0.006 and WC, p=0.01. A1C within grp: p=.001 in interv grp; No changes in BMI in either grp. Both grps have sig. life sat within-grp; both grps: sig. change in anxiety, depression.	HC with and without access to mobile technology improved glucoregulation and mental health in lower-SES. Accelerated improvement in m-phone grp provided more quickly adoption and adherence to health behaviors of home-based PA programs.
Pludwinski, et al. (2015) Cont. baseline	Interv grp: health coaching (HC) with m-phone-based self-monitoring Cont: HC without m-phone-based assistance	A1C	Experiences on diet, BG testing, meds and PA	A1C: sig reduced 1.38 %; increased control & confidence in dealing condition & gained knowledge of DM SM.	Smartphone-based behavior software helped track behavior, communicate with HC and adopt an active role in improving health.
Lim, et al. (2015) Cont: SMBG	Interv grp: clinical decision support system (CDSS) Cont. grp: self-monitored BG (SMBG)	A1C	PA, diet, BMI, WC, BP, caloric intake and lipid profile.	b/t interv & cont. grps: 3 & 6mons A1C p<.05; BMI and WC, p<.002; BP, p<.001; hypoglycemia p<.05; caloric intake and PA p<.05; lipid profiles improved	u-healthcare service provided effective management for older pts with T2DM and had better glycemic control, less hypoglycemic.

Table 2 continue

Reference / Control group	Intervention	Physiological outcomes	Behavior adherence /psychosocial	Results	Conclusion
Capozza, et al (2015) Cont: usual care	Interv grp: received b/t 1-7 DM-related text messages/ day-targeting, tailoring, PT control frequency text msgs.	A1C	PT's interaction & sats.	3 & 6mos A1C: within grp:improved; no stat sig b/t grps: p>.05; high level of sat in interv grp, mean score 27.7/32. Women more likely than men to drop out of the study at 6mos.	High sats in interv grp reflects unmet need for DM management & behavioral support for DM (A1C >8%). Program didn't provide information how to manage DM needs.
Quinn, et al (2015) Cont: Baseline	Interv: DM self-care data into the phone (BG, diet selection, meds, PA, DM information): engage users to self-manage their DM.	None	SE, QOL, reported DM symptoms, depression, sats,	SE improved from 7.7 to 8.0; reported DM symptoms from 30.2 to 23.8; depression from 5.3-2.9, p=.04; Sat. p=.01.	Users had high SE and high readiness & confidence ability to monitor changes & control DM. Demonstrated ability to use the mobile interv and communicate with DM providers.
Goh, et al. (2015) Cont: Baseline	Interv: food consumed via a food database with estimated calories in "Meal"; calculate estimated calories burned in "Workout"; "Step Counter"; "Social features": facebook-sharing & weight & to set a weight loss goal and track weight loss over time.	None	Health diet Exercise motivation Diabetes self-efficacy (DES-SF score:Diabetes Empowerment Scale-Short Form)	3 level of grp: 78.6% for mini; 11.9% for interm; 9.5% for consis. Diet and PA associated with consistent users, PA associated with interm.-waning users; female has higher odds of being consistent users than male; higher PA scores at baseline had higher odds or being interm.-warning users and consistent users.	Gender can play a role in determining app usage and a caloric-monitoring app; iDAT app can serve as an adjunct tool to facilitate lifestyle changes in conjunction with usual modality of counseling.
Cherrington, et al. (2015) Cont: Baseline	Interv: face to face encounter, 3mos weekly calls, and another 3mos monthly calls	None	Peer support: PA and diet, BG and meds adherence	Positive peer support on uncontrolled BG, Diet, appointment follow-up, meds adherence, exercise.	mHealth assisted CHWs in daily work while connect to healthcare team in real time. CHWs utilized msgs to relay pt's questions on meds, DM, SM issues to healthcare providers with continual feedback from end users.

Table 2 continue

Reference / Control group	Intervention	Physiological outcomes	Behavior adherence /psychosocial	Results	Conclusion
Aikens, et al. (2015) Cont: baseline	Interv: monitor pt's symptoms and SM problems; provide tailored msgs; generate guidance on SM support; actionable feedback provided	None	Meds adherence, PA; depressive symptoms, DM-related distress, psychological functioning	Sig in meds, PA, depression, and DM-related distress: $p<.001$; Didn't in psychological function: $p=.083$. 3 vs to 6 mos didn't have sig effects on IVR outcomes; Stat sig in SMBG, checking feet, BG: $p<.001$.	Combine auto telemonitoring & clinician notification & caregiver involvement may benefit to SM, in short & long term meds adherence, long term functional and DM-related distress, regardless of pt's age, income level, comorbidity, caregiver participants.
Burner, et al. (2014) Cont: baseline	Focus grps: via a series phone calls and text msgs.	None	Meds reminders, health believes, health behavior,	Believed it & improved participants' DM management: messages cued specific behaviors such as medication reminders, challenges messages.	TExTMED shows low-income Latino pts will accept text messages as a behavioral intervention. mHealth interv acts as a behavioral trigger rather than an ED platform.
Karhula, et al (2015) Cont: standard care	Interv: consisted of HC over mobile phones and self-monitoring of health parameters with the help of a remote patient monitoring (RPM) system.	A1C, BP, Wt, WC, BG, lipids	HRQL	B/T grps in DM: sig. WC p.01; within interv grp in DM: sig Wt p.02, WC $p<.001$, SBP<.001, DBP p.007, lipids<.001; within cont grp in DM: lipids decreased. B/T grps in DM: no sig in HRQL $p=.85$, and A1C	A health coaching program supported with telemonitoring didn't improve heart disease PTs' or DM HRQL or their clinical condition. Had a differential effect on heart disease & DM PTs. DM PTs had more prone to benefit from this intervention.
Haddad, et al. (2014) Cont: baseline	Interv: 1 text message per week to each PT – 5 ED related themes relating to diet, TX, complication awareness, BG monitoring, enhancement of clinic attendance.	A1C	DM knowledge, cost	Mean A1c stat sig $p=.001$, decreased 1.2% at 6mos; mean knowledge $p=.049$, increased from baseline to 6mos, 8.6 to 9.9; correlation b/t knowledge & A1c $p=.027$. Total text messaging cost 147.4 (Iraq), cost .065 per message.	Age, gender, educational level showed no association with changes in A1C or knowledge score. SMS is a feasible and acceptable way of promoting knowledge of DM and offer a cost-effective to provide ongoing healthcare support to PT.
Khanna, et al. (2014) Cont: baseline	Interv: ATNS, various cultural-specific dietary items and gives dietary feedback.	A1C	BP, BMI, WC, A1C, lipids	A1C: no stat sig $p=.41$; BP, BMI, WC, and lipids: no stat sig.	ATNS system didn't improve DM control in a Spanish-speaking population in Oakland.

Table 2 continue

Reference / Control group	Intervention	Physiological outcomes	Behavior adherence /psychosocial	Results	Conclusion
Arora, et al. (2014) Cont: usual care	Interv: TExT-MED – unidirectional daily 2 text message of generic care reminders to m-phone in English or Spanish	A1C	Meds adherence, ER utilization rate,	A1C reduced 1.05% in interv grp, 0.6% in cont grp; Med adherence gained in interv grp 4.5 to 5.4; proportion of ED from 36% versus 52% interv grp.	TExT-MED didn't have stat sign A1c, but improved in A1c, and QOL, meds adherence. Also it decreased ER utilization.
Waki, et al. (2014) Cont: usual care	Interv: DialBetics-triggered alerts to nurse and users. Nurse emails user after 1 week missed. DialBetics server to monitor their health data: BG, BP, Wt	A1C, FBS, BMI, BP, LDL-C, HDL-C, TG	Diet Exercise Meds adherence	A1C, p=.015 and FBG, p=.019 d in DialBetics grp; BMI, p=0.06 but improved to compare with non-interv. Grp. LDL, HDL, TG, BP, Med, Self-care (diet, PA) same in two grps.	Remote health data monitoring, plus real-time communication with pts, supported self-management of DM, resulted in improved A1C, even in just a 3 mos period.
Aikens, et al. (2014) Cont: baseline	First receive IVR calls weekly for 3 mos, 2nd IVR calls weekly for 6 mos – calls followed 3 structured algorithms, lasted 5-10 mins, gave verbal reinforcement and as needed SM messages based on their responses.	None	Reporting health & self-care problems; and self-treat on: Hyper/ hypo; Report on: BG Meds adherence Hyper/hypo BP symptoms	Low & high BG, self-treat low & high BG - all p<.001. Alert on high BP 55%, low BG 42%, low BP 12%, high BG 7%.; DM-related distress p=.018; health literacy p<.039; older pts p=.004; physically impaired p<.001; Med nonadherence p=.002; caregiver received notification p<.001	By providing reliable, valid actionable information, IVR based mHealth services increase access to b/t visit monitoring and DM SM support. Participating with an informal caregiver was associated with higher rates of call completion and weekly BP monitoring, and a lower rate of high BG levels.
Nagrebetsky, et al. (2013) Cont: No SMBG	Interv: at least 6 BG tests/wk, 3/6 to be fasting, uploaded to server; received graphical feedback on BG level via diary app to aid decisions on self-titration. BG readings were monitored by researchers 2x/wk via Web-based monitoring system.	A1C	Diet, PA, meds adjusting, safety on reporting hypoglycemia	Interv at 6mos: A1C 10 (-21 to 3) -0.9% (-1.9% to 0%); cont at 6mos: A1C -5 (-13 to 6)l, -0.5% (-1.2 to 0.6%). Interv: A1C p=.04 lower than baseline, and cont grp. Interv: higher change oral glucose-lowering meds compare with cont grp.	Self-titration of oral glucose-lowering meds in T2DM with self-monitoring and remote monitoring of glycemia is feasible, have potential to improve clinical outcomes.

Table 2 continue

Reference / Control group	Intervention	Physiological outcomes	Behavior adherence /psychosocial	Results	Conclusion
Rubi, et al. (2013). RCT study protocol) Cont grp: usual care	Two interventional groups, both groups use telemedicine (TM) app for 1 year study. One group received additionally HC during the first 4 mos.	A1C	2nd: QOL, depression, behavioral change, empowerment, PA, nutritional habits, PT's acceptability (usability, perceptions & experiences about mobile self-manage. Cost-effect.	It's study proposal.	To investigate the effect of TM app with and without HC, to question whether HC is important for the continued use of tools for PTs' health competence and acceptability. Whether HC part of interv. will motivate the pts or whether the repeated phone calls from DM nurse will become more tiresome than supportive and thus unwanted.
Torbiomsen, et al. (2014) (4 mos study) 50 to control	FTA, FTA-HC, FTA (Few Touch App): SM (via awareness, relevant factors, motivational feedback); measure BG, diet habit; PA, personal goal-setting, a general information (Ed). FTA-HC: received HC for the first 4 mos.	A1C	QOL (SF-36 scale); depression, SM (heiQ scale), PA and motivation, Diet, Usability scale, Meds adherence, Hypoglycemic events	A1C: b/t grps 3 grps: P=.65, decline in all grps. SM: FTA group to cont grp, P =0.01, FTA-HC to FTA and cont grps p=.04. Skills and technique acquisition: p=0.2 FTA higher to cont grps. No changes in any of the domains of the SF-36 (no sig. differ in QOL, diet, PA b/t 3 groups).	Use FTA DM diary with or without additional HC improved self-management in terms of ability to navigate health services and skills required to reduce symptoms. App and HC didn't help reduce HbA1c levels interv. grps with those who received usual care.
Holmen, et al. (2014) (12 mos study) 50 to control (41 by end of study)		A1C, Wt, BP, BMI, Lipids	QOL (SF-36 scale); depression, SM (heiQ scale), PA and motivation, diet, usability scale, accept (SUTAQ); meds adherence, hypoglycemic events	A1C: b/t grps, no differ after 1 year; but a decline in all grps. In FTA-HC grp, SM - skills and technique acquisition were greater to reduce symptoms & manage their health effectively. other 2nd outcomes- no differ b/t grps; aged equal or > 63 years more to be substantial users of the app.	No sig. differences in the change in A1C b/t intervs grps and contl grp. Skill and technique acquisition increased in those who received health counseling in addition to self-management app. Age may not hinder the use of technology.

Table 2 continue

Reference / Control group	Intervention	Physiological outcomes	Behavior adherence /psychosocial	Results	Conclusion
Lyles, et al. (2013) Cont: none	13 categories for safety triggers: pain, S/E of meds, high or low BG, difficulty with obtaining or adhering to meds, needing appoints or supplies. If occurs, a lay health coach to follow up with live PT calls.	None	Pain or meds side effect Checking BG & hyper or hypo BG Need appointment Needs equipments or meds & meds adherence	360 safety triggers among 155 participants- 53% individual and 7.6% all automated calls in 27 wks interv. The most common triggers: pain or med S/E 22%, experienced a safety trigger more than white.	Half triggered at least one potential safety event over 27 wks, more frequently in some pts. Systems of HIT strategies to improve self-care & remote monitoring should consider specific program design elements to address these potential safety events.
Osborn, et al. (2013) Cont: none	3 rounds iterative testing: each round assessed barriers to med adherence; pts interact with MED interv.	None	Meds adherence	Round 1:average response 10.25 (range 7-12); helpfulness 8.75 (1-10 scale). Round 2: helpfulness 8.33 (1 - 10); IVR, 6.5 (SD 3.27). Round 3: helpfulness 8.25 (1-10), response 9.83 (SD 2.4), IVR 8.33(SD 1.15). Found feedback useful	The intervention context was DM med adherence promotion among low-income adults with T2DM, the development strategy and usability/feasibility testing process is generalizable to other m- phone- based behavior change interventions with other patients' population.
Tatara, et al. (2013) Cont: none	Diabetes Diary: BG and step Counts, diet habits:	None	Maintain usage on BG, PA, diet habit.	Usage p<.05; BG; PA-decreasing usage trend p<.05 , Perceived usefulness high over time; BG sensor as the most motivating followed by PA then diet habit. BG control improved, small in PA & diet habit in 1 year course. Sat.level with tips function reduced over time; Factors: integration with everyday life; automation; balance b/t accuracy and meaningfulness of data with manual entry; intuitive and informative feedback; and rich learning materials (food).	FTA, a flexible learning tool depending on learner's needs as well as for regular self-monitoring. Usage of the app was supported by min. effort required for tracking activities and user-involved design process. Two factors: each participant's engagement with the tool over time; involving patient-users from an early phase of design-concept making to a longitudinal trial of the system.

Table 2 continue

Reference / Control group	Intervention	Physiological outcomes	Behavior adherence /psychosocial	Results	Conclusion
Orsama, et al (2013) Cont: usual care	Interv: automatic, theory-based, health promotion-information, motivation, behavioral skills feedback msgs, linked to PTs' remote reports of their health parameters & aimed at strengthening their self-care practice	A1C	BG, BP, Wt, PA (step counter)	Within interv: A1C p=.025, Wt p=.058, SBP and DBP p<.001, Within cont: A1C p=.98, Wt p.94, SBP and DBP p=.018 and p=.004 No stat sig b/t two grps on any values. No difference in meds adjustments; Sat is 100%; making health improvement is 90%.	Active technology for automated processing of health information from PTs in an ongoing interaction with technology which can achieved with semantic information processing of PT-reported data and delegation of decision-making to automated system,
Nes, et al. (2013) Cont: Baseline	Electronic diaries; personal written feedbacks; audio files with mindfulness exercises; FTA a healthcare tool installed on the smartphone.	A1C, FBG, BG, HDL, LDL, TG	ADDDoL-19 (Audit of diabetes dependence quality of life).	A1C deceased from baseline to end of interv, Mean average A1c before and after: 7.39% (SD 1.11); 6.9% (SD 0.8). (+) lifestyle changes: support in breaking habits and establish new health behavior. No results report on HDL, LDL, TG data and items on QOL.	Intervention is feasible and was evaluated as supportive and meaningful. Developed smartphone app seems a promising toll for supporting pts with T2DM to make important life style changes.
Burner, et al (2013) Cont: none	In same study phase I: PTs received 3 text messages a day in their preference of English or Spanish. Messages were: ED and motivation, health-behavior challenge, meds reminders.	None	Gender differences on dietary SE, seeking health information resource, desired content of ED materials	Men increased SE without increased knowledge; Women increased knowledge with little increased SE; Men had low dietary SE, relied on female relatives; men increased in fruit and vegetable intake; women had higher baseline level of fruit and vegetable intake	Efficacy of mHealth on DM manage affected by gender. Men and women differ in dietary SE, information sources, desired topics. To achieve maximal impact, mHealth intervention need to mindful of gender difference.
Williams, et al (2012) Usual care	Weekly call using a m-phone. Feedback, encourage, tailored inform. System "alerts" if any unusual clinical or other issues arose.	A1C	HRQL: health related quality of life. Mental HRQL (SF-36): Physical HRQL.	Interv: p=.002, A1C 8.7% to 7.9%, 0.8% decreased; usual care:8.9 to 8.7%, 0.2% reduced. HRQL p=.007, mental b/t 2 grps at 6 mos: improved in TLC DM group; PA HRQL b/t 2 arms p=0.7.	The efficacy of TLC DM program with clinically sig post-interv. improves in both A1C & mental HRQL. Accessibility and feasibility have strong potential proving effective, support to DM PT in the future.

Table 2 continue

Reference / Control group	Intervention	Physiological outcomes	Behavior adherence /psychosocial	Results	Conclusion
Logan, et al. (2012) Cont: no self-care support	Interv: self-care support readings on Smartphone.	None	BP and anxiety, depression	Intevt: mean daytime SBP p<.0001, B/T grp p<.005; mean daytime DBPp<.001. No changes in anxiety, worsen depression p=.014. B/t grps: no changes in total meds. Comfort with home BP monitoring in both grps p<.001, no b/t grp difference	Home BP telemonitoring combined with automated self-care support reduced BP of DM PTs with uncontrolled SBP and improved BP control. Home BP monitoring alone had no effect on BP. Promoting PT self-care have negative psychological effects.
Quinn, et al. (2011) Grp 1 -Cont: usual care (CU)	Grp 2: coach only (CO) Grp 3: coach & PCP portal (CPP) Grp 4: coach & PCP portal with decision support (CPDS).	A1C	Lipid, BP, DM distress, DM symptoms, PHQ-9 depression.	CPDS to CU: A1C p<.001 CO & CPP to UC: A1C p=.02, p=.045; All grps: decreased in lipid and BP; All grps: no changes in DM distress, DM symptoms.	Combine of behavioral mobile coaching with BG data, lifestyle, and PT SM data individually analyzed and presented with guidelines to providers substantially reduced A1C levels over 1 year.
Lyles, et al (2011) Cont: none	Interv: targeted 4 aspects of CCM: SM support, delivery system design, clinical information system, clinical decision support.	None	SM support, delivery system design, clinical information system, decision support	Connecting nurse practitioner is valuable; uploading data from glucose meters is easy, smartphones are frustrating, program helps users focus on self-care.	SM support user's self-care, increased health awareness. Graphical feedback displaying the recent trends of BG values was valuable. Technical difficulties in uploading self-monitoring BG values.

Abbreviations:

- # ....number
- b/t...........between
- BG..........blood glucose
- BMI........body mass index
- BP ....blood pressure
- CES-D....Center for Epidemiological Studies Depression Scale
- Cir..........circumference
- Cont. ......control
- DBP ....diastolic blood pressure
- DM.........diabetes
- FBG ....fasting blood glucose
- grp .... group
- HBM...... Health Believe Model
- HC .... health coaching
- HR .... heart rate
- HRQL.... health-related quality of life
- Interm. ... intermittent
- Interv ..... intervention
- MCS ...... Mental Composite Score
- meds ...... medications
- msgs....... messages
- MMAS... Morisky Medication Adherence Scale
- mos .... months
- PA ....physical activity
- PAID......Problem Areas in Diabetes
- PCS ....Physical Composite Score
- QOL ....quality of life
- r/t............related
- Sat. ....Satisfaction
- SBP ....systolic blood pressure
- Sig. ....significant
- SM..........self-management
- Stat. ....Statistically
- WC.........wrist circumference
- Wt ....weight

Ten studies measured blood pressure, with seven of these (70%) reporting clinically significant decreases in blood pressure level (Aikens et al., 2014; Karhula et al., 2015; Lim et al., 2015; Logan et al., 2012; Orsama et al., 2013; Quinn et al., 2011; Williams et al., 2012). Six studies measured lipids, and four of them (67%) reported clinically significant improvements (Karhula et al., 2015; Lim et al., 2015; Quinn et al., 2011; Williams et al., 2012). Nine studies included weight loss as an outcome, with seven of them (78%) reporting clinically significant decreases in weight (Lim et al., 2015; Orsama et al., 2013; Pludwinski et al., 2016; Ribu et al., 2014; Waki et al., 2014; Wayne et al., 2015; Williams et al., 2012).

Health Behavior Adherence Factors

This review focused on five health behavior adherence factors described in Brown et al.'s (2015) model-testing study: diet, physical activity, medication adherence, glucose self-monitoring skills, and appointment keeping. These key lifestyle behavioral factors have been studied previously as valuable predictors of diabetes outcomes (Brown, 1988, 1992).

As summarized in Table 2, all except two studies (93%) reported positive or improved glucose self-monitoring behavior (Karhula et al., 2015; Khanna et al., 2014). Of the 15 studies that measured dietary adherence, 12 (80%) reported improvements, and three (Khanna et al., 2014; Ribu et al., 2013; Waki et al., 2014) reported no change. Of the 16 studies that measured physical activities adherence, 14 (88%) reported positive changes (Aikens et al., 2015; Aikens et al., 2014; Arora et al., 2014; Cherrington et al., 2015; Goh et al., 2015; Lim et al., 2015; Lyles et al., 2011; Nes et al., 2013; Orsama et al., 2013; Pludwinski et al., 2016; Tatara et al., 2013; Verwey et al., 2016; Wayne et al., 2015; van der Weegen et al., 2015). Of the 12 studies that measured medication adherence, 10 (83%) reported positive behavioral changes (Aikens et al., 2015; Aikens et al., 2014; Burner et al., 2014; Cherrington et al., 2015; Lyles et al., 2013; Nagrebetsky et al., 2013; Osborn et al., 2013; Pludwinski et al., 2016; Ribu et al., 2013). Three studies that measured appointment keeping reported positive outcomes (Cherrington et al., 2015; Lyles et al., 2013; Ribu et al., 2013).

Our review found that the number of mHealth intervention studies has been increasing annually, suggesting an increasing interest in this area (Arnhold et al., 2014; Cotterez, Durant, Agne, & Cherrington, 2014). The studies were conducted in a variety of countries, and the average age of study participants trended toward a younger age group. The relatively younger participants were likely due to the inclusion criteria in most of the studies. Some investigators, for example, required that participants have smartphones or that they have sufficient cognitive function to enable the use of a smartphone. Younger patients are more likely to use smartphone apps, a factor that would increase effectiveness with younger populations.

The studies demonstrate that, as a whole, mHealth interventions have had positive effects on health outcomes; 93% of the studies demonstrated improved self-monitoring skills, and the vast majority demonstrated statistically significant improvements in A1C. More than 50% of the studies measured adherence to diet, physical activities, or medication self-administration; and 80% reported positive outcomes.

Few of the primary studies included in this review measured important physiological outcomes such as blood pressure, lipids, and weight/weight loss. Whereas 15 studies measured A1C, only 10 measured blood pressure, 6 measured lipids, and 9 measured weight/weight loss. Only three studies measured adherence to follow-up appointments with healthcare providers. These findings, which suggest that few mHealth apps provide a comprehensive set of tools to facilitate diabetes self-management, are similar to those of previous reviews (Chomutare et al., 2011; Cotterez et al., 2014; Nie et al., 2016; Ristau et al., 2013), and they also suggest commonly underemphasized areas in the development of diabetes mobile apps. Diabetes-related complications of blood pressure and high cholesterol are also integral aspects of diabetes self-management; however, a large percentage of the studies lacked these outcome measurements. There is much room for improvement in the development and testing of comprehensive diabetes self-management apps.

Another important finding was that half of the 28 studies used A1C as an inclusion criterion; in 8 studies, the baseline A1C was equal to or greater than 7.5% (Arora et al., 2014; Capozza et al., 2015; Cherrington et al., 2015; Khanna et al., 2014; Nagrebetsky et al., 2013; Osborn et al., 2013; Quinn et al., 2011; Williams et al., 2012).

These patients tended to be the most at risk for developing diabetes-related complications. Thus, mHealth interventions have the potential to assist high-risk groups with improving diabetes self-management.

Limitations

These findings apply to diabetes self-management of T2DM only, so they are not generalizable to other chronic diseases or diabetes co-morbidities. The studies employed mobile devices as their intervention tools, so the participants were limited to individuals able to use a mobile phone and the Internet.

Implications

Several recommendations can be made for future mHealth app development in diabetes self-management research and practice. Because of the reviewed studies' broad international scope, the findings may have global implications. Younger patients find it easier to adopt and use new technologies, so feasibility and usability of mobile technologies may need further research for older populations. mHealth is effective in improving physiological outcomes including A1C, blood pressure, and blood glucose, and the behavioral factors of adherence to diet, physical activities, medication self-administration, and glucose self-monitoring. Healthcare providers should be aware of the effectiveness of the various functions and mobile applications that are available in order to recommend the app best suited to a patient's needs.

It is necessary to examine the types of health information that patients with diabetes desire in order to develop comprehensive mobile apps for diabetes self-management. Individuals' information needs may depend on how long they have been diagnosed with diabetes, because knowledge needs change over time as a person's diabetes status changes.

CHINESE DIABETES MOBILE APPLICATIONS

Although the preceding literature review shows that mHealth interventions have positive effects on T2DM self-management and can improve health outcomes, there remain questions about the quality of health information found on the Internet and in mobile apps (Antheunis et al., 2013; Eysenbach, 2014; Eysenbach et al., 2002; van Berkel et al., 2015; Zhang, Sun, & Xie, 2015). Few apps offer all of the features that are considered necessary for effective diabetes management (Boulos, Brewer, Karimkhani, Buller, & Dellavalle, 2014). Inaccurate or incomplete information can have negative consequences such as increased anxiety (Silver, 2015), which can lead patients to use the Internet to search for health-related information excessively and in turn increase depression (Starcevic & Berle, 2013). Misinformation causes consumers frustration or dissatisfaction (Eysenbach, 2014).

Despite the high prevalence of diabetes and high adoption of cellphones in China (mobiThinking, 2014), there is a lack of knowledge about the quality of information available on diabetes-related Chinese mobile apps. To determine whether or how Chinese diabetes apps might be assisting Chinese patients in the self-management of their disease, one study has therefore examined the features and types of health information currently provided by Chinese diabetes mobile apps, using the HIW framework (Nie et al., 2016).

Features

Nie et al. (2016) defined six main features as functions that support patients' diabetes self-management. These features were adapted from Chomutare et al.'s (2011) study of mHealth diabetes self-management apps. The features were then combined with the U.S national standards for diabetes care (ADA, 2015), as well as the management of cardiovascular disease and risk (including blood pressure control and cholesterol monitoring). The final 15 features were identified as follows:

1. Education: general diabetes education information.

2. Diet management: information about diet/food/nutrition.

3. Weight management: weight information/weight monitoring.

4. Blood pressure: information about blood pressure checking and monitoring.

5. Physical activity/exercise: information about physical activities/exercise and monitoring/tracking of physical activities/exercise.

6. Communication/interaction with healthcare providers/PHR.

7. Insulin: information about insulin, dosage calculation, and self-injection.

8. Oral diabetes medication: information about oral diabetes medication, including administering and tracking of such medication.

9. Blood pressure: information about blood pressure and blood pressure monitoring.

10. Family: the sharing of information with family members and communicating with them.

11. Peers: the sharing of information with other patients with similar conditions and communicating with them.

12. Disease-related alerts/reminders regarding blood glucose, weight, diet, or follow-up appointments.

13. Calorie count: counting calorie intake.

14. Body mass index: recording, calculating, and monitoring BMI.

15. Cholesterol: information about cholesterol; cholesterol tracking/monitoring.

These 15 features are distinct, essential components for effective diabetes self-management.

Results

Nie et al. (2016) analyzed a total of 95 apps: 43 Android apps, 38 iOS apps, and 14 apps that run on both Android and iOS platforms. Their study showed that the number of Chinese diabetes mobile apps is increasing, with 59% of the selected apps released in 2014. This trend suggests that attention is focusing increasingly on diabetes mobile apps in China just as in the U.S. (Arnhold et al., 2014).

Education was the most common feature in the sample of Chinese diabetes apps, followed by blood glucose checking/information, diet/food/nutrition, insulin, and exercise/physical activities. These are also the most common features in diabetes apps in the U.S. (El-Gayar et al., 2013; Ristau et al., 2013), supporting the generalizability of the findings across national contexts.

The features of the Chinese diabetes apps had several limitations. First, few apps included more than 12 features, and 7 of the selected apps had no self-management feature at all, suggesting that few Chinese diabetes apps could provide a comprehensive set of tools to facilitate diabetes self-management (Arnhold et al., 2014; Chomutare et al., 2011; Demidowich, Lu, Tamler, & Bloomgarden, 2012). Second, as has been reported in studies of English-based apps (Chomutare et al., 2011; Cotterez et al., 2014; Ristau et al., 2013), psychosocial support that involves families and peers was featured in only a small percentage of the Chinese apps, suggesting an underemphasized area in the development of diabetes mobile apps across cultural and national contexts. Third, features such as disease-related alerts/reminders and information about blood pressure, cholesterol, and BMI are also integral aspects of care for diabetes self-management; however, a large percentage of the Chinese diabetes apps lacked these features, suggesting much room for improvement in developing comprehensive diabetes self-management apps.

None of the Chinese apps provided all the seven types of health information within the HIW framework. Six apps did not provide any of the seven types. The majority did not offer much information about psychosocial support, even though evidence suggests that psychosocial support affects patients' well-being (Cotterez et al., 2014; El-Gayar et al., 2013; Ristau et al., 2013). Evidence indicates that psychosocial interventions such as family support and peer support can improve patients' diabetes self-management (Cobden et al., 2010; Hua et al., 2013; X. Li et al., 2015; Silver, 2015; Tang et al., 2002; van Vugt et al., 2013). Not providing information about the psychosocial aspects of diabetes self-management is a missed opportunity that needs to be addressed in future Chinese app development. The majority of the Chinese apps also did not provide information about healthcare providers or facilities (or any feature to facilitate interaction with providers), which meant that those apps would not be useful in helping diabetes patients and their families make decisions about which physicians or facilities to go to.

CAM has been recommended as a supplement to standard treatments in chronic disease prevention and health promotion (Hawk et al., 2012). However, CAM information was the least likely type of health information to be provided by the Chinese apps. This, too, calls for more attention in future app development.

Evidence suggests that information about laboratory tests, CAM, healthcare providers, and psychosocial support are all important types of information that patients wish to have (Xie, 2009, 2011; Xie et al., 2014). Shared decision-making is at the core of self-management and patient-centered care. It requires not only that patients be actively involved in their own care and decision-making, but also that health providers provide services based on patients' personalized needs and preferences (Anderson & Funnell, 2002; Aujoulat et al., 2007; Bravo et al., 2015; Epstein & Street, 2011).

PREFERENCES FOR INFORMATION AND DECISION-MAKING

Information Seeking and Decision-making Preferences

A few decades ago, the dominant health-care decision-making model was a paternalistic model in which patients played a passive role in their own healthcare decision-making. From the 1970s on, the model has shifted to a shared decision-making model in which patients are expected to be informed and work with their healthcare providers to join in decision making (McNutt, 2004), and the patient–provider relationship has come to involve patients' information-seeking and decision-making preferences (Stiggelbout & Kiebert, 1997).

Patients are overwhelmingly interested in having detailed information, but they participate much less in decision making (Deber, 1996; Stiggelbout & Kiebert, 1997; Xie, 2009), which suggests a discrepancy between information-seeking and decision-making behavior (Deber, Kraetschmer, & Irvine, 1996; Xie, 2009). Why do patients want information, even if they do not want to use it to make decisions, and what do patients intend to do with the information after they obtain it? Xie's (2009) HIW framework answers these questions and has brought health information-seeking and decision-making preferences into the online world (Xie, 2009). Online information makes it possible for consumers to obtain information with relative ease (Fox & Duggan, 2012).

The provision of good information about health can influence consumers' healthcare choices, lower the costs of healthcare, and improve the quality of care (Hibbard & Jewett, 1996). If healthcare providers know patients' preferences for health information, healthcare will become less costly, more effective, and more geared toward patients' desires (Brennan & Strombom, 1998). Patients do want to participate in medical decision-making along with their healthcare providers (Mühlhauser, Albrecht, & Steckelberg, 2015). Participation can improve outcomes for patients who suffer from chronic illness (Näsström, Jaarsma, Idvall, Årestedt, & Strömberg, 2014). Knowing patients' preferences for health information is the core concept of the shared decision-making model (Xie et al., 2015).

Health Information Wants (HIW)

Xie's (2009) HIW framework, driven by grounded theory, focuses on the concept of HIW, that is, "health information that one would like to have and use to make important health decisions that may or may not be directly related to diagnosis or standard treatment" (p. 510). This framework describes preferences for information and decision-making autonomy, and it explains the discrepancy in previous studies between patients' preferences for health information seeking and decision-making participation.

According to the HIW framework (Xie, 2009), patients typically want four types of health information. Type I is basic information about diseases and treatments that can help patients understand what to expect and how to cope with the psychosocial stresses of disease and treatment. Type II consists of more advanced, detailed information about diagnosis and treatment obtained from healthcare providers, which enables patients to participate in decisions about their care. Type III consists of information about CAM, which may help patients engage in dietary changes, exercise, and weight control and promote health behavior changes. Such information does not replace standard treatments but supplements patients' typical healthcare. Finally, Type IV consists of provider-related health information, which can help patients make better decisions about physicians or facilities to address their health issues. This type of information represents the highest degree of patients' autonomy, such that patients can decide what healthcare providers they wish to have, and, ultimately, participate in determining their diagnosis and treatment. While doctors may not be the ideal source to provide all four types of health information that patients want, the Internet has the potential to perform that function (Xie, 2009).

The use of third-party resources such as the Internet to obtain desired information represents patients' empowerment (Xie, 2009; Xie et al., 2011; Xie et al., 2014), and it increases patients' trust in healthcare providers. The four types of information that patients want were subsequently operationalized in the HIWQ to seven types of health information and decision-making autonomy: information and decision-making about the specific health condition, treatment, laboratory tests, self-management, psychosocial aspects, CAM, and healthcare providers (Xie et al., 2011; Xie et al., 2010, 2014).

Type I: This is the basic information about disease and treatment. The convenience and availability of mHealth makes it a good option for meeting this type of HIW. It is so much easier to obtain basic information through mHealth than it is to go to a doctor (Xie, 2009). With this type of information, patients can prepare themselves to cope with psychosocial stresses about their health condition and treatment.

Type II: This information is more advanced, detailed information about the health condition and treatment. Patients want this type of information so they can be better prepared to interact with doctors and to monitor doctors' decisions (Xie, 2009). mHealth helps patients gather such information, facilitating empowerment. Doctors are not necessarily the best source for meeting this type of HIW (Xie, 2009), but mHealth can be.

Type III: Information about complementary alternative treatment, such as herbal supplements, meditation, chiropractic care, and acupuncture, can enable the patient to engage in helpful activities. Doctors may not have the time to consider such treatments. mHealth can provide this type of information for less critical decisions, even though doctors are still the primary source for critical information and decision-making (Xie, 2009).

Type IV: The ability to use a source other than doctors to obtain necessary information for making decisions about which doctor to see or which facility to go to is important for patient empowerment (Xie, 2009). This type of health information gives patients great autonomy in that they can investigate the credentials and reputations of providers and facilities. Patients may delegate authority regarding their health conditions and decision-making for treatments to doctors, but decisions about doctors to whom that authority should be delegated are made by patients independently (Xie, 2009).

The HIW framework provides a new approach to examine how patients make decisions about their care, and the HIWQ measures the types and amounts of health information that patients would like to have in order to make decisions that may or may not be associated with their diagnosis and basic treatment (Xie et al., 2014). This framework distinguishes the health information that patients desire from what healthcare providers think their patients require, promoting a new way to understand patients' preferences from the patient's perspective (Xie, 2009).

SUMMARY

China has the world's largest prevalence of diabetes, due to an aging population, fast economic development, urbanization, and transitions in nutritional status, all of which are significant public health problems. Evidence suggests that providing adequate health information and empowerment to patients would improve patients' self-management and enhance outcomes. As a whole, mHealth interventions in China had positive effects on health outcomes, but only a few studies measured important physiological outcomes (blood pressure, cholesterol, weight/weight loss), adherence to follow-up appointments with healthcare providers, and quality of life. A second review of the features and types of health information provided by existing Chinese T2DM mobile apps showed that the majority of Chinese apps did not provide many features and types of health information essential for diabetes self-management, and only a small percentage of apps provided information about blood pressure, cholesterol, and BMI. Both reviews suggest gaps in existing diabetes apps which lack comprehensive features and a diverse range of information based on patients' preferences for health information topics, as well as formatting that would guide decision-making about diabetes treatment and self-management. Further study is needed to explore preferences for types and amounts of health information and for decision-making autonomy in Chinese T2DM so that mHealth can facilitate Chinese T2DM self-management.

CHAPTER 3: METHODS

The purpose of this study is to explore and understand (1) individual preferences for types and amounts of health information and decision-making autonomy in Chinese patients with T2DM; (2) how mHealth can be used by Chinese patients with T2DM; and (3) the relationship between mHealth use and preference for types and amounts of health information and participation in decision-making in Chinese patients with T2DM. Using the HIWQ and mHealth-related questions, a cross-sectional survey in Chinese patients with T2DM was conducted. A better understanding of the preferences for types and amounts of health information and decision-making, of how mHealth has been used, and of the relationship between mHealth use and preferences for types and amounts of health information and participation in decision-making by Chinese patients with T2DM can provide not only important implications for medical practice, but also functional knowledge that can be used by healthcare providers who work with T2DM patients to determine the types and amounts of health information that they should provide, as well as what kinds of mobile apps would be useful for patients in order to empower them in T2DM self-management.

This chapter includes a discussion of (a) the preliminary studies; (b) the study design, setting, and participants; (c) the method of data collection; (d) data management, analysis, and synthesis; and (e) ethical considerations.

PRELIMINARY STUDY

The present study builds on a pilot study conducted in China with a refined version of the HIWQ during the summer of 2016. That pilot study was informed by an earlier prior study that involved cognitive interviews held in the spring of 2016 to refine the HIWQ.

Cognitive Interviews

The HIWQ has been validated among older and younger Americans (Xie, 2009; Xie et al., 2011) and Chinese cancer patients (Xie et al., 2015). It was developed "to empirically examine the relationships between types of preferences in information and decision-making" (Xie et al., 2011, p. 279). Empirical evidence shows that this instrument has excellent validity and reliability (Xie, 2009; Xie et al., 2015; Xie et al., 2011). The HIWQ was already translated into Chinese and validated for the cancer context (Xie et al., 2015), and so, to adapt it for Chinese patients with T2DM, we conducted cognitive interviewing to identify and evaluate the quality of participants' responses (Beatty & Willis, 2007; Drennan, 2003) and develop a culturally relevant survey instrument. On relevant items, cancer-specific wording was altered to diabetes-specific wording in simplified Chinese by a bilingual investigator and co-investigator, and items were verified for accuracy and consistency by another co-investigator who is an endocrinologist in China. For instance, "information about severity of cancer" was changed to “information about severity of diabetes”; “decision regarding the cancer’s progression” language was changed to “decision regarding the diabetes’ progression.”

The cognitive interviews explored what Chinese patients with T2DM thought about the questionnaire’s content. After obtaining Institutional Review Board (IRB) approval from The University of Texas at Austin, we recruited six participants from the Asian Chinese Activity Center in Austin for the interviews. Verbal consent was obtained from each participant prior to beginning the interviews. It took about 20 to 30 minutes for each participant to complete the adapted HIWQ survey. Multiple rounds of cognitive testing were then conducted to verify how participants perceived and interpreted the questions (i.e., a decentering method). The wording of the instrument was revised based on participants’ feedback. The original copy of this instrument is available from the primary investigator upon request.

The Pilot Study

In the summer of 2016, a pilot study was conducted at the Sichuan Academy of Medical Science/Sichuan Provincial People’s Hospital (henceforth referred to as “the Hospital”) in China. In the pilot study, a cross-sectional survey using a pen-and-paper questionnaire was administered to 52 participants recruited from the hospital’s endocrinology clinic. The survey was completed by each participant in about 20 to 30 minutes. The findings indicated that the HIWQ had excellent reliability, with Cronbach’s (1951) alpha (α) coefficients of .95 for information and .91 for decision making. For the information subscales, α ranged from .81 to .96; for the decision-making subscales, alphas ranged from .78 to .97. Participants' mean age was 57.17 (*SD*= 9.76). The survey participants expressed higher levels of preference for information than for decision making. Participants desired more information on treatment, laboratory tests and self-management; information on CAM and psychosocial factors were requested least. The strongest desires for participation in decision making were found on the psychosocial and healthcare provider subscales; the lowest desires for participation in decision making were found on the subscales for treatment and laboratory tests. Age, gender, and employment were not associated with any preferences, but income and marital status were associated with preferences regarding healthcare providers.

Based on feedback from both patients and dissertation committee members, questions in the HIWQ were revised for accuracy and readability. For example, "Information about the benefits and risks of different laboratory tests, e.g., urine test, blood test, etc." was revised to "Information about the benefits and risks of different laboratory tests, e.g., A1C, fasting blood glucose, 2-hour post-prandial glucose test, cholesterol tests". Several questions were revised according to diabetes self-management guidelines. We added five diabetes behavior adherence indicators (diet, physical activities, medication adherence, glucose monitoring skills, appointment keeping). Exemplar questions asked about information regarding how to check BG at home and how often; how to take the prescribed medication (e.g., injecting insulin or taking oral medication); how to adjust my diet to eat healthier; how to engage in physical activity, etc. Two questions, information about how this health condition may affect my work and how this health condition may affect my personal life, were combined into one, because the pilot study participants' average age was 57.7 years, so that most of participants were retired. Once the items on the health information dimension were revised, corresponding or parallel items on the decision-making dimension were revised as well.

We adapted the Health Tracking (Pew Research Center, 2013) and U.S. Smartphone Use (Pew Research Center, 2015) survey questions for use within the Chinese context to explore how mHealth could be used to facilitate Chinese patients' T2DM self-management. The mHealth-related questions included, for example, "How often do you use a smartphone?" "Do you receive any text updates or alerts about health or medical issues from your doctors or nurses?" "Do you use your smartphone to look for health or medical information?" "What kind of health applications do you currently have on your cellphone?"

After multiple rounds of revision, the final survey questionnaire was translated into simplified Chinese. The questionnaire was verified by two bilingual committee members and an endocrinologist in China. The final questionnaire comprised 24 questions on the information dimension and 24 corresponding parallel questions on the decision-making dimension to explore preferences on both dimensions. Ten mHealth-related questions asked about how mHealth was being used.

THE PRESENT STUDY

Design

This study used a quantitative, cross-sectional survey in the form of a pen-and-paper questionnaire. The survey instrument included four parts (see Appendix A for English and Appendix B for Chinese versions).

Parts 1 and 2: These two parts are the HIWQ: Part 1 for health information preferences and Part 2 for preferences for decision-making autonomy. The original HIWQ from Xie et al. (2012; 2013) was translated into simplified Chinese for Chinese cancer patients' in Xie et al. (2015). For the present study, we adapted the HIWQ with revised wording and added five diabetes behavior adherence indicators. The HIWQ was revised based on feedback from the cognitive interviews and the pilot study with Chinese patients with T2DM as described above. The HIWQ's Information Preference Scale and Decision-making Preference Scale, two scales of parallel items on seven subscales, operationalize specific areas of health information and decision making that patients may desire in medical encounters. Each scale has a total of 24 items.

The seven subscales measure preferences related to health condition (items 1-4), treatment (items 5-7), laboratory tests (items 8-10), self-management (items 11-16), CAM (items 17-19), psychosocial aspects (items 20-22), and healthcare providers (items 23-24). On the Information Preference Scale, participants indicate their preference for each item on a five-point Likert scale from 1 = *none* to 5 = *all*. On the Decision-making

Preference Scale, participants indicate their preferences for each item on a five-point Likert scale from 1 = *doctor alone* to 5 = *myself alone*.

In addition to the seven subscales, three items were later used as controls: "How long have you been diagnosed with diabetes?" "How severe do you think this health condition is?" and "How knowledgeable do you think you are about this health condition?" In the Information Preference Scale, one global item assesses preferences for information in general: "Overall, how much information would you like to have about this health condition?" In parallel, one global item in the Decision-making Preference Scale assesses preferences decision-making in general: "Overall, who do you think should make decisions related to this specific health condition?"

Part 3: This part comprised the mHealth questions adapted from the Health Tracking (Pew Research Center, 2013) and U.S. Smartphone Use (Pew Research Center, 2015) survey questions.

Sample questions included: "Do you have a smartphone?" "How often do you use your smartphone?" "How often do you access the Internet on a smartphone, tablet or other mobile handheld device?" "Do you receive or read health-related posts or information via your smartphone or via mobile health apps on your smartphone?"

Part 4: This part included questions about participants' demographics: age, gender, marital status, general health status, household income, education level, health insurance, and employment status.

Setting

This study's research site was the Sichuan Academy of Medical Science/Sichuan Provincial People's Hospital (referred to as "the Hospital" hereafter), a general hospital located in Chengdu, the capital of Sichuan province, China. The Hospital was initially founded in 1941 and has over 4,300 beds. The Endocrinology Department opened in 1978 and has 83 inpatient beds. It served over 80,000 outpatients in 2016. In addition, the Endocrinology Department has over 2,500 inpatients per year. This site was selected because: (a) we have a reliable local collaborator who is willing and able to help recruit research participants with relative ease; (b) the feasibility of this site was already tested and established in the pilot study; and (c) the Hospital is a top-rated facility that serves as a major teaching hospital, with patients primarily from Southwest China, which is an economically underdeveloped region.

Southwest China includes the provinces of Sichuan, Yunnan, Guizhou, and Tibet. The Sixth National Population Census of the People's Republic of China (2010 Chinese Census) ranked Chinese provinces for percentage of completion of primary and higher education from the lowest to the highest. Out of 31 provinces in China, Guizhou was ranked the lowest, followed by Tibet and Yunnan. Sichuan was the sixth lowest. This may be compared with Beijing, in the Northeast region, which ranked the highest, followed by Shanghai in the Southeast region, which ranked second. In terms of population, Sichuan province was ranked the fourth most populated province in China, with a population of over 82.3 millions (2010 Chinese Census).

More information on the Hospital is available at: http://www.samsph.com/about/707/1/.

Participants

Inclusion/exclusion criteria: Participants were (a) 18 years of age or older; (b) able to read simplified Chinese; (c) able to hear and see normally with or without correction; (d) able to communicate in Mandarin; (e) not diagnosed with any memory or cognitive problems (as determined by the patient's self-report and verified by our local Chinese collaborator who has had longer term interactions with these patients); and (f) diagnosed with T2DM (reported by patient and verified by our local Chinese collaborator who is an endocrinologist).

Recruitment: The recruitment strategies were the same as those used successfully in the pilot study. The sample was obtained through word-of-mouth at the Endocrinology Department clinic by our local collaborator, endocrinologist Dr. Yan Yang, who has been working at the hospital for over 20 years. Because the IRB at The University of Texas at Austin and the Hospital Research Ethics Committee in China approved the pilot study, an addendum for this dissertation study was submitted to The University of Texas at Austin. After the addendum was approved, the primary investigator (PI) visited the Hospital and provided the print questionnaire for the participants to complete on site.

Individuals interested in participating in the study who met the inclusion criteria were recruited on site by the co-investigator at the clinic. Participants were then directed to one of the consultation rooms located down the hallway from the clinic in a relatively quiet area. Interested individuals were given an information sheet that explained the study and were informed that participation was voluntary, with no anticipated risks. Any concerns that a participant had were addressed by the PI. The verbal consent form was obtained from each participant before the survey was administered. The total time for completing the instrument was approximately 30-35 minutes per participant. Recruitment continued until the target sample size ($N = 200$) was reached.

DATA MANAGEMENT

Rescoring strategy. On the basis of Xie's studies (Xie et al., 2015; Xie et al., 2013; Xie et al., 2014) and Ende et al.'s (1989) scoring strategy, the scores of the HIW questions "were rescaled to have a midpoint of 50, with 0 corresponding to *the least amount of information wanted or doctor alone to make the decision related to this health condition*, and 100 corresponding to *the greatest amount of information wanted or patient alone to make the decision related to this health condition*). The data were rescaled by linearly transforming the original score as follows: rescored score = (raw score - 1) * 25." This rescaling strategy allowed us to compare the scores of the information and decision-making dimensions.

The first three mHealth questions were scored on a Likert-type scale where 1 = *never,* 2 = *rarely,* 3 = *occasionally*, 4 = *frequently*, 5 = *very frequently*. Question 4 was scored as categorical variable as 0 = *never*, 1 = *less than one year*, 2 = *more than one year, less than three years*, 3 = *more than three years, less than five years*, 4 = *more than five years, less than ten years,* 5 = *more than ten years*. Question 6 was scored as categorical variable as 0 = *never,* 1 = *less than once a month*, 2 = *more than once a month*, 3 = *once a week*, 4 = *every 2-3 days*, 5 = *every day*. Questions 5, 7, 8, and 9 scored as 1 = *yes,* 2 = *no*, and 3 = *don't know*. The descriptive statistical data analysis indicated low frequency for "*don't know*"; the original data entries were then recoded with "*don't know"* removed, and data were recoded as 1 = *yes* and 2 = *no*. Question 9 comprised eight items about using a smartphone to do various things; each one was recorded as 1 = *yes* or 2 = *no*. Question 10 asked patients what kinds of apps they downloaded (participants could select more than one). This was then scored as the total number of health-related apps participants had on their smartphones.

Demographic data were scored categorically. For marital status, 181 out of 200, or about 90.5% of participants, were married, while there were very small numbers of participants who indicated they were single, separated, divorced, or widowed. Marital status was therefore recoded as dummy variables: 1 = *married*; 0 = *other marital status*. For employment status, full-time participants were 56 out of 200, or about 28%; retired participants were 114 out of 200, or about 57%; and part-time and unemployed participants made up about 15%. For statistical analysis, employment status was recoded as dummy variables: 1 = *full-time*, 0 = *others*.

Data management and analysis. IBM SPSS version 20.0 was used for data analysis. Data were entered by the primary investigator and analyzed using descriptive, parametric, and non-parametric tests. The one-tailed significance level was set at .05. Descriptive analysis was used to check for accuracy and missing values. Missing data were managed with pairwise deletion, which was appropriate in this study, so that all data were analyzed without any additional deletions (Nummaly & Bernstein, 1994). To ensure accuracy, the primary investigator also randomly selected 50 samples to review the entries and checked for typographical errors or erroneously entered data. Two typo-related errors were found. The primary investigator randomly selected another 50 samples to review the entries and checked for typographical errors; no more errors were found.

RELIABILITY AND VALIDITY

Reliability

Cronbach's (1951) α coefficient was used to measure internal consistency, an estimate of reliability. Cronbach's α measures how well items representing the same construct yield similar results. If Cronbach's α is equal or greater than .70 for information and decision-making preferences, respectively, this would indicate that items within each dimension were internally consistent and reliable. If Cronbach's α for the subscales within the information preference dimension and decision-making preference dimension was greater than .70, then all the subscales were reliable.

Construct Validity

The Mplus statistical program was used for confirmatory factor analyses (CFA) to test the construct validity of the HIWQ. CFA tested whether the items within each dimension (information preferences vs. decision-making preferences) reflected the seven distinctive factors measured by the subscales (Simon, et al., 2010). Items were loaded on their respective latent factors and correlations between latent factors were freely estimated in order to determine whether the seven-factor model fit the data well for both the information-seeking dimension and the decision-making dimension, using X^2, the comparative fit index (CFI), the standardized root mean square residual (SRMR), and the root mean square error of approximation (RMSEA). Positive results would support the hypothesized seven-factor structure of the HIWQ for Chinese patients with T2DM.

Convergent Validity

Pearson correlations were used to examine the relationship between the overall score for information preferences and the global item measuring overall preferences for information, and the relationship between the overall score for decision-making preferences and the global item measuring overall preferences for decision-making. If these measurements were statistically significant, the correlations would support the convergent validity of the Information Preference Scale and Decision-making Preference Scale.

STATISTICAL ANALYSES

Research Question 1.1: What types and amounts of health information and decision-making autonomy do Chinese patients with T2DM want?

For types and amounts of health information preferences and decision-making autonomy in Chinese patients with T2DM, we conducted a descriptive statistical analysis to analyze and address this research question.

Research Question 1.2: What is the relationship between preferences for health information and decision-making autonomy in Chinese patients with T2DM?

To test the relationships between preferences for health information and decision-making autonomy, general linear model statistical analyses were conducted. Before the analyses, assumptions for linear relationships were tested to determine that the observations of the two variables were independent for each participant, that the measure of the two variables was an interval scale, and that the relationship between the two variables was linear, using a scatterplot.

General linear model statistical analyses were conducted with repeated measures after controlling for age group, gender, marital status (married vs. others), household income level, general health condition, education level, health insurance, and employment status (fulltime vs. others), as well as severity of the condition, how knowledgeable participants were about this condition, and how long ago this condition had been diagnosed.

The first factor had two levels (health information and decision making), and the second factor had seven levels (seven subscales for health information corresponding to decision-making). The results of these tests for within-subject effects were analyzed to address this research question.

Research Question 1.3: What individual factors (e.g., demographics, years been diagnosed with diabetes) are associated with the types and amounts of health information and decision-making autonomy that Chinese patients with T2DM want?

General linear model statistical analyses using repeated measures with age group, gender, marital status (married vs. others), household income level, general health condition, education level, health insurance, and employment status (full-time vs. others), as well as perceived severity of the condition, how knowledgeable participants were about this condition, and how long ago this condition been diagnosed as covariates. Tests for between-subjects effects were analyzed and addressed for this research question.

Research Question 1.4: What is the relationship between subscales for health information preferences and decision-making in Chinese patients with T2DM?

Pearson correlations were conducted for each subscale of health information and corresponding decision making to examine relationships between the two scales for each type of health information and decision making: information and decision-making about the specific health condition, treatment, laboratory tests, self-care, CAM, psychosocial support, and healthcare providers.

Before we conducted Pearson's *r*, assumptions were tested to determine that observations for the two variables were independent for each participant, that the measure of the two variables was an interval scale, and that the relationship between the two variables was linear, using a scatterplot.

Research Question 2.1: What is the frequency of Chinese patients with T2DM using smartphones to access the Internet?

Smartphone use to access the Internet was measured by the following item: "How often do you access the Internet on a smartphone, tablet or other mobile handheld device?" Responses ranged from 1 = *never* to 5 = *very frequently*. Descriptive statistics analysis addressed this research question.

Research Question 2.2: What percentage of Chinese patients with T2DM uses smartphones to look for health-related information?

Smartphone use to look for health-related information was measured by the following item: "Do you ever use your smartphone to look for health or medical information online?" Responses were 1 = *yes*, 0 = *no*. Descriptive statistics analysis addressed this research question.

Research Question 2.3: What is the extent of types and amounts of health-related apps in the smartphones of Chinese patients with T2DM?

The types and amounts of health-related applications in the smartphones were measured by the following item: “What kind of health apps do you currently have on your smartphone?” The answer choices were: exercise, fitness, pedometer apps; monitor heart rate apps; diet, food, calorie counter apps; monitor weight apps; period or menstrual cycle apps; monitor blood pressure apps; pregnancy apps; blood sugar or diabetes apps; medication management (e.g., tracking, reminder, alerts, etc.) apps; mood apps; and sleep apps. Descriptive statistics analysis addressed this research question.

Research Question 2.4: What individual factors (e.g., demographic, years been diagnosed with diabetes) are associated with smartphone use frequencies in Chinese patients with T2DM?

Smartphone use frequency was measured by the following item: “How often do you use a smartphone?” Responses ranged from 0 = *never t*o 5 = *every day*. There were 12 predictors: age, gender, marital status, health status, household income, education level, health insurance, employment status (full-time vs others), years been diagnosed with diabetes, perceived severity of the condition, and how knowledgeable participants were about the condition. Linear regression statistical analyses addressed this research question.

Research Question 2.5: What individual factors (e.g., demographic, years been diagnosed with diabetes) are associated with smartphone use to look for health or medical information in Chinese patients with T2DM?

Smartphone use to look for health or medical information was measured by the following item: “Do you ever use a smartphone to look for health or medical information online?” Responses were 1 = *yes*, 0 = *no*. There were 12 predictors: age, gender, marital status, health status, household income, education level, health insurance, employment status (full-time vs others), years been diagnosed with diabetes, perceived severity of the condition, and how knowledgeable participants were about the condition. Linear regression statistical analyses addressed this research question.

Research Question 3.1: What is the relationship between smartphones use frequency and information and decision-making preferences?

Smartphone use frequency was measured by the following item: “How often do you use a smartphone?” Responses ranged from 0 = *never* to 5 = *every day*. General linear model analyses with repeated measures addressed this research question.

The first factor had two levels (health information and decision-making). The second factor had seven levels (seven subscales for the health information scale with seven corresponding of decision-making scale). Smartphone use frequency was the covariate.

Research Question 3.2: What is the relationship between the overall health information wanted and smartphone use to receive health-related posts via smartphone-based social networking apps?

Smartphone use to receive/read health-related posts via smartphone apps that support social medial was measured by following item: “Do you ever use your smartphone to receive/read health-related posts via cellphone apps that support social media, e.g., WeChat, QQ?” Responses were 1 = *yes,* 2 = *no*. Pearson correlation statistical analysis addressed this research question.

PROTECTION OF HUMAN SUBJECTS

IRB approval from The University of Texas at Austin and the Hospital Ethics Committee in China were obtained prior to any data collection. Participation was voluntary. Instead of obtaining signed written consent, we provided information that described the study to each participant prior to any data collection. This research presented no more than minimal risk and involved procedures that did not require written consent when performed outside of a research setting. Participants (patients with T2DM) were given a cover letter explaining the study aims, scope, and procedures in detail in simplified Chinese. We asked participants to provide verbal consent prior to any data collection (see Appendix C for English and Appendix D for Chinese verbal consent forms). As specified in this cover letter, completion of the survey questionnaire served as the written record of participants’ consent to participate in the study. Participants were instructed to complete the survey independently. On average, completion of the questionnaire took approximately 30 -35 minutes. Upon completion, each participant was thanked.

Privacy and Confidentiality

Participation in this research project was completely voluntary. Extreme care was taken to ensure confidentiality of participants' responses. We did not collect any data until participants provided verbal consent to participate. No personally identifiable information was collected. Thus, any publications based on this study would not include any personally identifiable information.

The PI entered the data into an Excel file and then transferred into SPSS for analyses; the PI also scanned the paper questionnaires as electronic files. The files were saved on a password-protected computer, and all files were emailed to The University of Texas (UT) at Austin email accounts and uploaded onto UT Box. The hard copy questionnaires were placed in a suitcase and brought back to the U.S. from China by the PI after the survey was completed.

The completed hard copy questionnaires are stored in a locked file cabinet in the PI's office. After completion of the study, the data will be kept for 5 years. During this 5-year period, the data may be used for future research or made available to other researchers for research purposes upon written request to the PI. After this 5-year period, the data will be destroyed physically and electronically.

Potential Benefits and Risks

This study was not designed to directly benefit the research participants. This survey was not part of participants' normal treatment, and there was no therapeutic value in completing the survey. However, the results may help researchers to explore preferences for types and amounts of health information and decision-making that T2DM patients want and how mHealth might facilitate T2DM self-management, and it may lead to improvements in practice and T2DM patients' health outcomes. The study risks are no greater than those encountered in everyday life.

SUMMARY

This dissertation study used a study framework based on previous cognitive interviews and a pilot study to explore types and amounts of health information preferences and decision-making autonomy, how mHealth can be used and facilitated in Chinese patients with T2DM, and how mHealth influences preferences for types and amounts of health information and decision-making autonomy. Two hundred participants completed the health questionnaire survey independently. Their concerns and questions during the survey were answered by the PI on site. Each participant took approximately 30 - 35 minutes to complete the survey. Data were entered and verified by the PI. Data coding was verified by Dr. Betty Zhou. HIWQ, mHealth, and demographic data were collected to examine the types and amounts of health information preferences and decision-making autonomy in Chinese patients with T2DM, how mHealth has been used, and whether mHealth might facilitate self-management in Chinese patients with T2DM.

This exploratory study should have potential to improve medical practice and patients' health outcomes. It may enhance the patient-provider relationship and improve patient-centered care.

CHAPTER 4: FINDINGS

This chapter describes the findings of the present study. The first section of this chapter will describe the sample (participants' characteristics), then instrument reliability and validity. The remaining sections will present the findings of the study pertaining to each of the research questions.

PARTICIPANTS' CHARACTERISTICS

A detailed description of the sample is presented in Table 3.

Table 3: Participants' Characteristics (N = 200)

Variables		
Years been diagnosed with diabetes	Minimum	0.1
	Maximum	27.7
	Mean (*SD*)	7.40 (6.50)
Age (years)	Minimum	26
	Maximum	90
	Mean (*SD*)	59.91 (12.17)
Gender, *n* (%)	Female	89 (44.5)
	Male	111 (55.5)
Marital status, *n* (%)	Married	181 (90.5)
	Single	4 (2.0)
	Separated	0 (0)
	Divorced	6 (3.0)
	Widowed	9 (4.5)
Health status, *n* (%)	Poor	24 (12.0)
	Fair	126 (63.0)
	Good	44 (22.0)
	Very good	5 (2.5)
	Excellent	1 (0.5)
Household income, *n* (%)	Very low	4 (2.0)
	Low	45 (22.5)
	Medium	143 (71.5)
	High	6 (3.0)
	Very high	1 (0.50)

Table 3 continue

	Don't know	1 (0.50)
Education level, *n* (%)	No formal education	17 (8.5)
	Less than high school graduate	57 (28.5)
	High school graduate	38 (19.0)
	Vocational training	6 (3.0)
	Associate / Technical school	48 (24.0)
	Bachelor's degree	33 (16.5)
	Master's degree	1 (0.5)
	Doctor's degree	0 (0)
Health insurance, *n* (%)	Yes	191 (95.5)
	No	9 (4.5)
Employment, *n* (%)	Full-time	56 (28.0)
	Part-time	7 (3.5)
	Unemployed	23 (11.5)
	Retired	114 (57.0)

RELIABILITY

We used Cronbach's (1951) α coefficient, a measure of internal consistency, to estimate reliability—how well items representing the same construct yield similar results. Cronbach's α = .95 and .90 for the overall health information and decision-making preferences, respectively, which indicates that items within each dimension were internally consistent and reliable.

Cronbach's α for the subscales within the health information preference dimension ranged from .76 to .94; Cronbach's α for the subscales within the decision-making preference dimension ranged from .70 to .96. All subscales were reliable (see Table 4).

Table 4: HIWQ Reliability

Dimension:	Health Information Wants (α = .948)	Decision-Making (α = .899)
Subscales:		
Health condition	α = .764	α = .690
Treatment	.888	.800
Laboratory test	.924	.756
Self-care	.932	.829
CAM	.943	.958
Psychosocial support	.868	.785
Healthcare providers	.887	.931

VALIDITY

Convergent Validity

Convergent validity was examined by correlating the overall health information scores with a global item ("How much information would you like to have about this health condition?") and the overall decision-making scores with a global item ("Who do you think should make the decision related to this specific health condition?").

The scaled score for information preference was positively correlated with the global item measuring preference for health information $r = .618$, $p <.01$. The scaled score for decision-making preference was also positively correlated with the global item measuring preference for decision-making $r = .480$, $p < .01$. These significant correlations support the convergent validity of the two scales.

Construct Validity

Confirmatory factor analyses (CFA) were conducted to examine the instrument's construct validity. CFA tested whether the items reflected the seven distinctive factors measured by the subscales. The seven-factor model was specified by loading items on their respective latent factors and freely estimating the correlation between the seven latent factors.

The results showed that the seven-factor model fit the data: for the health information dimension, results showed that the seven-factor model fit the data well, Chi-square Test of Model Fit value was [X^2 (231)] = 569.95, $p < .01$, comparative fit index (CFI) = .925, standardized root mean square residual (SRMR) = 0.05, and root mean square error of approximation (RMSEA) = 0.09. For the participation in decision-making dimension, results showed that the seven-factor model fit the data well, too, X^2 (231) = 577.25, $p < .01$, CFI = 0.89, SRMR = 0.08, and RMSEA = 0.09. These results support the seven-factor structure of the instrument for preferences for health information and participation in decision-making.

FINDINGS WITH REGARD TO THE RESEARCH QUESTIONS

This study explored preferences for types and amounts of health information and participation in decision-making of Chinese patients with T2DM, how mHealth might be used by Chinese patients with T2DM, and the relationship between mHealth and preferences for information and participation in decision-making.

Aim 1: To explore individual preferences for types and amounts of health information and decision-making autonomy in Chinese patients with T2DM. The research questions were:

Research Question 1.1: What types and amounts of health information and decision making autonomy do Chinese patients with T2DM want?

Overall, participants had higher levels of preferences for information than for decision-making. Participants desired more information on laboratory tests, self-management, and treatment, than on CAM, psychosocial aspects, health condition, and healthcare providers; and participants wanted to participate more in decision-making about healthcare providers and psychosocial aspects and less about laboratory tests, treatments, and the specific health condition (Table 5).

Table 5: Preferences for Information and Participation in Decision-making

Subscale	Information		Decision-making	
	Mean	*SD*	Mean	*SD*
Health condition	73.26	21.78	15.06	16.98
Treatment	80.13	22.22	9.92	14.50
Laboratory tests	82.13	22.34	9.83	15.26
Self-management	81.33	22.12	36.35	23.23
CAM	68.88	32.19	23.29	29.80
Psychosocial	67.89	27.52	59.40	34.08
Health care provider	77.13	25.72	66.13	35.52

Research Question 1.2: What is the relationship between preferences for health information and decision making autonomy in Chinese patients with T2DM?

Results from statistical general linear analyses with repeated measures showed that tests of within-subject effects factor 1 (health information wanted) did not interact with decision-making, $F\ (1) = 2.055$, $p = .153$ ($p > .05$); and factor 2 (decision-making autonomy) did not interact with health information, $F\ (6) = 1.728$, $p = .111$ ($p > .05$). The interaction between factor 1 and factor 2 was statistically significant, $F\ (6) = 3.141$, $p = .005$ ($p < .05$). This suggested that there was an interaction between health information wants and decision-making autonomy. The strength of this effect varied across the seven subscales.

Research Question 1.3: What individual factors (e.g., demographic, years been diagnosed with diabetes) are associated with the types and amount of health information and decision-making autonomy that Chinese patients with T2DM want?

Tests of between-subjects effects showed that gender ($p = .003$, $p < .05$), health status ($p = .034$, $p < .05$), and knowledge about their health condition ($p = .034$, $p < .05$) had positive effects on preferences for types and amounts of health information and decision-making autonomy.

Results indicated that female participants had a higher desire for health information and decision-making participation than male participants. The participants who rated better in general health status had a higher desire for health information and decision-making participation than those who rated poorer in general health status. The more knowledgeable participants were about their condition, the more health information wanted and participation in decision-making, as opposed to participants who had less knowledge about their condition.

Research Question 1.4: What is the relationship between each subscale of health information preferences and decision-making autonomy in Chinese patients with T2DM?

Pearson correlation statistical analysis showed that overall, the subscales for preferences for health information and their corresponding subscales for decision-making autonomy were negatively related – participants wanted more information but did not desire to participate in decision-making alone on the subscales for health condition, treatment, laboratory tests, CAM, and healthcare providers. The subscales of self-management ($r = -.146$, $p < .05$) and psychosocial aspects ($r = -.139$, $p = .05$) were negatively statistically significant. This indicated that participants wanted information about self-management and psychosocial aspects, but did not want to make those decisions on their own without doctors (Table 6).

Table 6: Subscales Relationship in Information and Decision-making

Subscales	Pearson correlation / sig. (2-tailed)
Health specific condition	-.055 / .442
Treatment	-.055 / .443
Laboratory tests	-.055 / .439
Self-management	-.146 / .039
CAM	-.073 / .304
Psychosocial aspects	-.139 / .050
Healthcare providers	-.023 / .746

Aim 2: To explore how mHealth can be used by Chinese patients with T2DM. The research questions are:

Research Question 2.1: What is the frequency of Chinese patients with T2DM using smartphones to access the Internet?

Descriptive statistics showed that 30.5% of study participants never used smartphones, tablets, or other handheld devices to access the Internet, 16% did so rarely, 15.5% occasionally, 29.5 frequently, and 8.5% did so very frequently (see Table 7).

Table 7: Internet and Cellphone Use Patterns

Variables		Participants: *n* = 200 (%)
How often use the Internet, *n* (%)	Never	61 (30.5)
	Rarely	33 (16.5)
	Occasionally	33 (16.5)
	Frequently	52 (26.0)
	Very frequently	21 (10.5)
How often send or receive email, *n* (%)	Never	95 (47.5)
	Rarely	39 (19.5)
	Occasionally	33 (16.5)
	Frequently	22 (11.0)
	Very frequently	11 (5.5)
How often access the Internet on a cellphone, tablet, or other mobile handheld device, *n* (%)	Never	61 (30.5)
	Rarely	32 (16.0)
	Occasionally	31 (15.5)
	Frequently	59 (29.5)
	Very frequently	17 (8.5)
How long used a smartphone, *n* (%)	Never	28 (14.0)
	< 1 year	17 (8.5)
	1-3 years	39 (19.5)
	3-5 years	43 (21.5)
	5-10 years	46 (23.0)
	>10 years	27 (13.5)
Do you have a smartphone, *n* (%)	Yes	167 (83.5)
	No	31 (15.5)
	Don't know	2 (1.0)

Table 7 continue

How often do you use a smartphone, *n* (%)	Never	28 (14.0)
	< once a month	2 (1.0)
	>once a month	6 (3.0)
	Once a week	7 (3.5)
	Every 2-3 days	7 (3.5)
	Every day	150 (75.0)
Receive any TEXT updates or alerts, *n* (%)	Yes	79 (39.5)
	No	105 (52.5)
	Don't know	16 (8.0)
Any software apps to track or manage, *n* (%)	Yes	53 (26.5)
	No	134 (67.0)
	Don't know	13 (6.5)
Use cellphone to send or receive email, *n* (%)	Yes	72 (36.0)
	No	126 (63.0)
	Don't know	2 (1.0)
Use cellphone to send text messages, *n* (%)	Yes	156 (78.0)
	No	44 (22.0)
	Don't know	0
Use cellphone to take a picture, *n* (%)	Yes	158 (79.0)
	No	41 (20.5)
	Don't know	1 (0.5)
Use cellphone to access the Internet, *n* (%)	yes	116 (58.0)
	No	83 (41.5)
	Don't know	1 (0.5)
Use cellphone to look for health or medical information online, *n* (%)	Yes	101 (50.5)
	No	96 (48.0)
	Don't know	3 (1.5)
Use cellphone to check bank account, *n* (%)	Yes	80 (40.0)
	No	118 (59.0)
	Don't know	2 (1.0)
Use cellphone to receive/read health-related posts	Yes	142(71.0)
	No	56 (28.0)
	Don't know	2 (1.0)
Use cellphone to receive/read health-related information via mobile health apps, *n* (%)	Yes	66 (33.0)
	No	131 (65.5)
	Don't know	3 (1.5)

Research Question2.2: What percentage of Chinese patients with T2DM use smartphones to look for health related information?

Descriptive statistics showed that 50.5% of Chinese patients with T2DM used smartphones to look for health related information (Table 8).

Table 8: Activities on Smartphones

Chinese Patients with T2DM Who Used Smartphone To:	*n* (%)
Take a picture	158 (79)
Send/receive message	156 (78)
Receive/read health-related posts via social media (WeChat, QQ)	142 (71)
Access the Internet	116 (58)
Look for health or medical information online	101 (50.5)
Check bank account	80 (40)
Send/receive email	72 (36)
Receive/read health-related information via mobile health apps	66 (33)

Research question2.3: What types and amounts of health-related applications are in the smartphones of Chinese patients with T2DM?

Descriptive statistics showed that a total of 209 health-related apps were downloaded to participants' smartphones, and 24% of Chinese patients with T2DM had at least one app downloaded to their smartphones. The most commonly downloaded apps were exercise/fitness apps, followed by diet, food, calorie counting apps, and blood sugar or diabetes apps, then weight monitor, sleep, and heart monitor apps (Tables 9 and 10).

Table 9: Numbers of Apps Downloaded in Smartphones

Number of health-related apps downloaded	*n* (%)
0	101 (50.5)
1	48 (24.0)
2	26 (13.0)
3	12 (6.0)
4	5 (2.5)
6	3 (1.5)
7	5 (2.5)

Table 10: Types of Apps Downloaded in Smartphones

Types of health-related apps	Sum of apps (%)
Exercise/fitness	80 (40)
Diet, food, calorie counter	37 (18.5)
Blood sugar or diabetes	37 (18.5)
Weight	15 (7.5)
Sleep	11 (5.5)
Monitor heart rate	10 (5.0)
Blood pressure	8 (4)
Medication management	5 (2.5)
Mood	3 (1.5)
Period or menstrual cycle	2 (1)
Pregnancy	1 (0.5)

Research question 2.4: What individual factors (e.g., demographic, years been diagnosed with diabetes) are associated with smartphone use frequencies in Chinese patients with T2DM?

Linear regression statistical analyses showed that 12 predictors (age, gender, marital status, health status, household income, education level, health insurance, employment status, years been diagnosed with diabetes, perceived severity of the condition, and how knowledgeable participants were about the condition) together explained approximately 14.3% of the variability in smartphone use frequency [$R^2 = .195$, adjusted $R^2 = .143$, F (12, 187) = 3.768, $p < .05$].

Results indicated that there was a significant negative relationship between age ($t = -3.748$, $p < .05$) and frequency of smartphone use, and a significant negative relationship between severity of health condition ($t = -2.393$, $p < .05$) and frequency of smartphone use.

Research Question 2.5: What individual factors (e.g., demographic, years been diagnosed with diabetes) are associated with using smartphones to look for health information in Chinese patients with T2DM?

Linear regression was conducted with 12 predictors: age, gender, marital status, health status, household income, education level, health insurance, employment status (full-time vs others), years been diagnosed with diabetes, perceived severity of the condition, and how knowledgeable participants were about the condition.

Results showed that these 12 predictors together explained approximately 25% of the variability in use of smartphones to look for health information [$R^2 = .293$, adjusted $R^2 = .247$, F (12, 184) = 6.35, $p < .01$].

Results indicated that there was a significant negative relationship between age ($t = -4.005$, $p < .01$) and looking for health information online; a significant positive relationship between education level ($t = 3.07$, $p < .01$) and looking for health information online; and a significant positive relationship between how knowledgeable participants were about the condition ($t = 2.35$, $p < 0.05$) and looking for health information online.

Aim 3: To explore the relationship between mHealth use and preference for types and amounts of health information and participation in decision-making in Chinese patients with T2DM.

Research Question 3.1: What is the relationship between smartphone use frequency and information and decision-making preferences?

Smartphone use frequency was measured by the following item: "How often do you use a smartphone?"

General linear model analyses with repeated measures were conducted. The tests of within-subject effects factor 1 (health information wanted) was statistically significant, $F(1) = 71.73$, $p < .01$, but factor 1 (health information wanted) did not interact with smartphone use frequency, $F(1) = .573$, $p > .05$. Factor 2 (decision-making autonomy) was statistically significant, $F(6) = 29.65$, $p < .01$, but factor 2 didn't interact with smartphone use frequency, $F(6) = .43$, $p > .05$. The interaction between factor 1 and factor 2 was statistically significant, $F(6) = 47.33$, $p < .01$, and smartphone use frequency, factor1, and factor 2 had a statistically significant three-way interaction, $F(6) = 2.90$, $p < .01$.

Research Question 3.2: What is the relationship between the overall health information wanted and the use of smartphones to receive health-related posts via smartphone-based social networking apps?

Pearson's correlation showed that $r = 0.193$, $p < .01$, indicating a statistically significant positive relationship between the overall health information wanted and the use of smartphones to receive/read health-related posts via smartphone-based social networking apps (e.g., WeChat, QQ).

SUMMARY

The study instrument had excellent validity and reliability. Overall, participants wanted to have a broad range of health information and decision-making autonomy, and the relationships between health information and decision-making preferences varied across the seven subscales. The individual' factors (gender, participants' general health status, and knowledge about their health condition) play an important role in HIW. About half (50.5%) of participants use smartphones to look for health information, and 24% of participants have at least one health-related app downloaded. Participants' increasing age and perceived severity of health condition tend to decrease their frequency of smartphone use. Participants' age, education level, and knowledge of their health condition also influence their use of smartphones to look for health information.

CHAPTER 5: DISCUSSION

This chapter will discuss the study's findings regarding: (1) preferences for health information and decision-making autonomy in Chinese patients with T2DM, including the findings, the gaps, and the implications; (2) mHealth use by Chinese patients with T2DM; and (3) relationships between mHealth use and preference for types and amounts of health information and participation in decision-making in Chinese patients with T2DM. The limitations of the study and future directions will be discussed, followed by a summary in the final section.

The study's findings show that this version of the HIWQ has high validity and reliability. These findings, along with other studies validating the instrument in both younger and older American (Xie et al., 2012, 2013), and Chinese cancer patients (Xie et al., 2015), support the validity and reliability of the HIWQ across populations and national contexts.

PREFERENCES FOR HEALTH INFORMATION AND DECISION-MAKING AUTONOMY IN CHINESE PATIENTS WITH T2DM

Aim 1:

To explore individual preferences for health information and decision-making autonomy in Chinese patients with T2DM.

A patient-centered care model is facilitated when health care providers consider patients' preferences for health information and encourage participation in decision-making. Research on patient-centered care model suggests that health information that patients want may differ from what healthcare providers think patients need (Xie, 2009). Focusing on what patients' want promotes an understanding of the patient from the patient's perspective rather than the healthcare provider's (Xie, 2009; Xie et al., 2015). If healthcare services are not personalized according to patients' needs and preferences, empowerment may not hindered, and healthcare providers cannot improve patients' quality of life and healthcare outcomes (Aujoulat et al., 2007; Epstein & Street, 2011; Tol et al., 2015; Wildevuur & Simonse, 2015). To promote a patient-centered healthcare system, one must understand not only patients' preferences for health information and decision-making autonomy, but also their relationships (Xie et al., 2013).

Overall, participants of this study wanted more information on laboratory tests, self-management, and treatment than on CAM, psychosocial aspects, health condition, and healthcare providers; participants wanted to participate in decision-making most regarding healthcare providers and psychosocial aspects, only somewhat regarding self-management and CAM, and less regarding laboratory tests, treatments and health condition. These findings are similar to prior research studies (Xie et al., 2012, 2013, 2015), as Chinese patients with T2DM wanted a wide range of health information, including but not limited to, information about treatment, laboratory tests, and self-management.

Chinese T2DM patients' lowest desire for participation in decision making occurred for standard laboratory tests and treatment, but their preferences for health information on the corresponding subscales were among the highest. This finding is similar to prior research study (Xie et al., 2012) showing older America adults' preferences for health information and participation in decision-making.

On the healthcare provider and psychosocial aspects subscales, participants expressed a strong desire for preference of information, as well as a strong desire for participation in decision-making. In China, patients rely more heavily on family for information and advice (Smith & Smith, 1999), which may be a result of the Confucian collectivist tradition in Chinese culture, interdependent relationships structure, in which people at a lower level status are obedient to those at a higher status, and which affects relationships of all kinds, extending from the family to the national level (Lam et al., 2010; Lee, R. N. 1986). However, on subscales for health condition, self-management, and CAM, participants expressed a strong desire for health information, but a relatively lower preference for participation in decision-making.

In a previous study of health information wants in Chinese cancer patients and family caregivers (Xie, et al., 2015), information about the specific health condition and laboratory tests were the two types of information most wanted, and information about CAM and psychosocial aspects were the two least wanted. In the present study, information about laboratory tests and self-care were the two types of information most wanted, but information about the specific health condition was not. Information for CAM and psychosocial aspects were the two least wanted, as in the study conducted by Xie et al. (2015). It is possible that diabetes patients in general have more experience with their health condition (mean years been diagnosed with diabetes being 7.4), and would thus want to focus more on obtaining information about treatment, laboratory tests, and self-management instead of information about diabetes in general.

These findings are similar with other studies that found patients were interested in having detailed information but much less in decision-making participation (Deber, 1996; Stigelbout & Kiebert, 1997; Xie, 2009; Xie et al., 2013). Effective diabetes self-management depends on patients' receiving sufficient information about the disease itself, treatment options, diet and nutrition, physical activities, safe use of medications, blood glucose monitoring, self-administration of insulin, prevention and treatment of complications, and ongoing psychosocial support (Haas et al., 2013). Patients want more detailed information about treatment, laboratory tests, and self-management so they can better prepare to interact with doctors and to monitor doctors' decisions (Xie, 2009). Through receiving sufficient information, patients become empowered (Aujoulat et al., 2007), then effective diabetes self-management can improve (Caburnay et al., 2015; Chomutare et al., 2011; Yang, & White, 2013).

Preferences for health information and decision-making autonomy differed, with the strength of those differences varying across the seven subscales. Individuals' factors, including gender, participants' general health status, and knowledge about their health condition, also corresponded to differences in preferences for information and decision-making participation. Female participants had a greater desire for health information and decision-making participation than did male participants. Goh et al. (2015) and Xie et al. (2015) similarly found that female participants wanted more information than did male participants. Age had no predictive effect on overall preferences for health information and participation in decision-making. Xie et al. (2012) similarly found that age made no difference between desire for health information and participation in decision-making.

The participants in this study who had better general health status had greater preferences for health information and decision-making participation than those with poorer general health status. The more knowledgeable the participants were about their health condition, the more health information and participation in decision-making they wanted, compared with those less knowledge about their health condition. When patients are informed and more knowledgeable about their disease and treatment, they are more empowered to take an active role in managing their own health (Aujoulat et al., 2007; Calvillo, Roman, & Roa, 2013; Rossi et al., 2015).

Evidence indicates that empowerment in Chinese patients with diabetes is a statistically significant predictor of behavior changes in diet, exercise, BG testing, and medication adherence, as well as reduction in A1C (Yang, Hsue, & Lou, 2014). Effective diabetes self-management depends on patients receiving sufficient information about the disease, treatment options, diet and nutrition, physical activities, safe use of medications, BG monitoring, self-administration of insulin, prevention and treatment of complications, and ongoing psychosocial support (Haas et al., 2013). With more knowledge about their diabetes, patients can be more empowered for effective diabetes self-management. This empirical study indicated that more knowledgeable patients are more interested in participating in decision-making. This finding suggests that preferences for health information and participation in decision-making are important components for patients' empowerment and self-management.

With respect to relationships between the corresponding subscales for health information and decision-making preferences, overall there was a negative relationship between the two scales. Participants wanted more information on treatment (mean 81.13, SD 22.22) and health condition (mean 73.26, SD 21.78), but they didn't want this information in order to make decision alone (mean of treatment was 9.92, SD 14.50; mean of health condition was 15.06, SD 16.98). This empirical finding supports Xie's (2009) HIW framework for "health information that one would like to have and use to make important health decisions that may or may not be directly related to diagnosis or standard treatment" (p. 510).

Gaps

In the review of characteristics of existing Chinese mHealth apps for diabetes self-management, information about laboratory tests, CAM, and healthcare providers was missing from most apps (Nie et al., 2016). It is suggested that few Chinese diabetes apps could provide a comprehensive set of tools to facilitate diabetes self-management. The literature review showed that only 3 out of 28 studies measured patient's adherence to follow-up appointments with healthcare providers which indicates that the follow-up with healthcare providers was understudied. Follow-up with healthcare providers is one of the behavior indicators for effective T2DM self-management (Brown et al., 2015). Our study results indicate that Chinese patients with T2DM wanted a wide range of health information and participation in decision-making. Information about laboratory tests was the most wanted information, and independence in decision-making about healthcare providers was the most desired. However, patients want more detailed information about treatment, laboratory tests, and self-management so they can better prepare to interact with doctors and to monitor doctor's decisions (Xie, 2009), and to become empowered through receiving sufficient information (Aujoulat et al., 2007), upon which effective diabetes self-management depends (Haas et al., 2013). The Institute of Medicine has defined patient-centered care as respectful and responsive to individual patient preferences and needs (Committee on Quality of Health Care in America, 2001). Thus the gaps exist between current studies and our study.

Implications

The present study's findings have implications for mHealth developers, health education interventions, and physician-patient interactions. Chinese diabetes apps need to include a wider range of health information to empower patients in diabetes self-management. In order to better target patients' needs and to reflect more effectively patients' desires for information on specific topics rather than generalized health education programs, health education intervention and program planners need to consider the participants' gender, health status, and knowledge about their health condition. In addressing issues related to specific health conditions, treatment, laboratory tests, self-management, CAM, psychosocial aspects, and healthcare providers, healthcare professionals should be sensitive to the patient's desire for a role in decision-making; communications should be tailored accordingly to patients' needs; and information provided should be customized to match patients' personal preferences for information and to address patients' perceptions and social factors (Xie et al., 2013, 2011, 2015)

These findings provide strong support of the HIW theoretical framework, which promotes a patient-centered approach. The findings suggest the importance of understanding patients' preferences for health information and participation in decision-making to improve the effectiveness of patients' self-management of their T2DM.

mHealth Used by Chinese Patients with T2DM

Aim 2

To explore how mHealth might be used by Chinese patients with T2DM. Results showed that 33% of Chinese patients with T2DM occasionally accessed the Internet, and 83.5% of them owned a smartphone. Of the Chinese population as a whole, 71% of

Chinese occasionally accessed the Internet (Pew Research Center, 2017), but Chinese patients with T2DM had a much lower likelihood of accessing the Internet. This may be because our study participants were primarily from southwest China. Per the 2010 Chinese Census, the southwest region was ranked the highest in terms of population, but the lowest for percentage completion of primary and higher education. Our study indicates that education level has a positive impact on patients' use of smartphones to look for health information online. mHealth apps provide a set of tools to facilitate diabetes self-management (Chomutare et al., 2011; Cotterez et al., 2014; Ristau et al., 2013). However, the participants of Chinese patients with T2DM in our study may be negatively impacted by their low education level when it comes to accessing health information online.

In September 2012, the Pew Research Center conducted a Health Tracking Survey of American adults' cellphone use (Pew Research Center., 2013). A total of 3,014 adults of living in the United States were interviewed by telephone. The survey showed that American adults used smartphones mainly to do three things: taking pictures, sending/receiving messages, and accessing the Internet. Of health-related apps downloaded in American adults' smartphones, the most frequently found types were those related to: exercise, fitness, pedometer or heart rate monitoring; diet, food, and calorie tracking; and weight management.

In the present study, we adapted the Health Tracking Survey's questions to explore how Chinese patients with T2DM used their cellphones to do things, and what amount and types of health-related apps were downloaded in their smartphones (see Tables 8, 9, and 10).

Our study was done 5 years after Pew's, and it is difficult to compare the two results, given this difference in time as well as differences in the participants' demographic backgrounds. However there are still commonalities between the smartphone use of Chinese patients with T2DM and that of American adults. Smartphone use was highest for picture taking, sending/receiving messages, and Internet access, just as in the Pew study. The amount and types of downloaded health-related apps were highest for exercise fitness apps, followed by diet, food, calorie counting, and weight management apps in both our study and Pew's (2013). Because our study's participants had T2DM, diabetes app use was higher among them than among American adults. This finding is similar with Pew's (2013) that people living with chronic conditions are significantly more likely to track a health indicator. Nonetheless, our Chinese patients with T2DM had much in common with American adults in the way both groups used smartphones to do things and in the downloaded types and amount of health-related apps. This shows that mHealth is a resource for seeking health information across nationalities.

mHealth use by Chinese patients with T2DM. In the present study, the smartphone use frequency and demographics (age, gender, marital status, health status, household income, education level, health insurance, employment status), and years been diagnosed with diabetes, along with the perceived severity of the condition and participants' knowledge about their condition, explained approximately 14.3% of variability in smartphone use frequency. This suggests that these factors may play an important role in smartphone use frequencies among Chinese patients with T2DM. Younger participants and those with a perceived lower severity of diabetes were also more likely to have a higher smartphone use frequency. These findings are similar to those of Health Tracking Survey 2012 in American adults (Pew Research Center, 2013).

Results also showed that 12 predictors (age, gender, marital status, household income, education level, health insurance, employment status, years been diagnosed with diabetes, perceived severity of the condition, and how knowledgeable participants were about the condition) explained approximately 25% of the variability in the use of smartphones to look for health information online. Thus, these factors may play an important role in smartphone use to look for health or medical information online in Chinese patients with T2DM. Younger Chinese patients with T2DM looked for health or medical information online more often than did older participants; those participants with a higher educational level and more knowledge about their health condition were also more likely use smartphone to look for health or medical information online. In Pew's 2012 survey (Pew Research Center, 2013) younger American adults and those with higher education also had a greater desire to use smartphones to look for health or medical information online than did older adults and those with lower education.

Of Chinese patients with T2DM, 58% reported smartphone use to access the Internet, and 51% of them used a smartphone to look for health or medical information online. This suggests that mHealth is an important resource for Chinese patients with T2DM while they are looking for health information. Of American smartphone users who were over the age of 50 years, 20% had at least one health app on their mobile devices (Shetty & Hsu., 2016). In our study, 24% of Chinese patients with T2DM with an average age of 59.91 years (from a range of 26 to 90 years) had at least one health-related app on their smartphones. Thus, mHealth has been used by Chinese patients with T2DM for seeking health-related information.

mHealth empowerment in patients with T2DM's self-management. How can mHealth empower patient in their self-management? Technology can empower patients to access information online and acquire knowledge about their health status so that they can make informed decisions. It provides new ways to connect patients and healthcare providers and empower patients' self-management of chronic diseases (Calvillo et al., 2013). People with a chronic disease who have Internet access are more likely to use the Internet to find health-related information than those who do not have a chronic disease (Fox & Purcell., 2010). Frequent Internet users prefer significantly more information and decision-making participation than do infrequent Internet users (Xie et al., 2013).

Evidence shows that increased app exposure has an effect on various clinical measurements, in particular for BMI and systolic blood pressure (Hartin et al., 2016), and those who used an app more than 7 times per week appeared to have the largest reduction in BMI and blood pressure (Hartin et al., 2016). Of Chinese patients with T2DM, 75% of them used a smartphone every day, 24% of them had at least one health-related app downloaded in their smartphone, 71% used a smartphone to receive/read health-related posts via social media (WeChat, QQ), and 50% used a smartphone to look for health information online. This indicates that Chinese patients with T2DM have the potential to be empowered by mHealth to improve various clinical measurements.

As of 2014, 62% of American adult smartphone owners used their cellphones to look for information about health conditions (Pew Research Center, 2015). Using a smartphone to search for information about health conditions increases patients' satisfaction, empowerment, and engagement (Lee, 2016). Empowerment helps people assert control over the factors that affect their health (Calvillo et al., 2013). In our study, more than 50% of Chinese patients with T2DM used smartphones to access the Internet and look for health or medical information online, 40% had downloaded exercise, fitness, or pedometer apps, and 24% had at least one health-related app downloaded to their smartphones. These findings suggest that these mHealth use behaviors could empower these patients to become more responsible for and involved in their treatment and diabetes self-management.

Gaps

Within the healthcare system, there is a significant demand to provide diabetes self-management education and support networks (Haas et al., 2013; Rossi et al., 2015). Not only because there is a deficiency of diabetes educators (Sultan & Mohan, 2012), but also due to the limited amount of healthcare resources (Weymann, Härter, & Dirmaier, 2016). However, advances in technologies, such as the smartphone, offer new opportunities to increase and enhance diabetes self-management education to help make up this gap (El-Gayar et al., 2013).

Frequent Internet users prefer to have significantly more information and decision-making participation than infrequent Internet users do (Xie et al., 2013). The present study showed that 16.5% of participants occasionally use the Internet, and 26% frequently use the Internet, while participants who had higher educational levels were more likely to use their smartphones to search for health information online than participants with lower education levels. The participants in this study were primarily from Southwestern China, including the provinces of Sichuan, Yunnan, Guizhou, and Tibet. In a ranking that classified the 31 Chinese provinces in terms of their percentage of primary and higher education completion, Guizhou was ranked the lowest, followed by Tibet, Yunnan, and Sichuan (2010 Chinese Census). These gaps may affect Chinese patients with T2DM in acquiring health information via Internet.

Implications

The present study's findings have implications for healthcare providers and educators: demographics (age, education level), and knowledge about their health condition may play an important role in smartphone use frequencies among Chinese patients with T2DM. Of Chinese patients with T2DM, 71% reported smartphone usage for receiving or reading read health-related posts via social media (such as WeChat), and 51% of them used a smartphone to look for health or medical information online. This suggests that mHealth is an important resource for Chinese patients with T2DM while they are looking for health information. To provide diabetes-related information and education, healthcare providers and educators need to recognize that older or less educated Chinese patients with T2DM may need more assistance in comparison with younger patients or those with higher education levels, because patients who are younger or at a higher education level are more likely to access the Internet to seek health-related information.

MHEALTH WITH HIW

Aim 3

To explore the relationship between mHealth use and preferences for types and amounts of health information and participation in decision-making autonomy in Chinese patients with T2DM.

There is growing evidence that patient-centered care will lead to empowerment for diabetes self-management (Rossi et al., 2015). If healthcare services are not personalized according to patients' needs and preferences, patients cannot be empowered. Patient-centered care requires an understanding of patients' preferences for health information and decision-making autonomy (Xie et al., 2013). With increased smartphone use, a growing number of patients have smartphones they can use to search for health information and to find apps to help manage their disease (Riza & Atreja, 2016).

Relationship between preferences for health information and participation in decision-making with mHealth. This study's findings provide evidence of a three-way interaction between smartphone use frequency, preferences for heath information, and participation in decision-making, which suggests that smartphone use frequency is associated with the differences between information preferences and decision-making participation. The strength of those differences varied across the seven subscales for information wants and participation in decision-making. Frequent smartphone users preferred more information and participation in decision-making autonomy than did infrequent smartphone users. This finding is similar with the Xie et al. (2013) study of Internet use frequency and patient-centered care. Also this finding is similar to other studies (Hartin et al., 2016; Rubi et al., 2013; Waki et al., 2014) of frequency of mHealth usage related to patients with T2DM in effectiveness of self-management.

WeChat and QQ are two of the most used communication apps in China (Jodel, 2011). About 71% of the Chinese patients with T2DM in this study used smartphones to receive/read health-related posts via WeChat or QQ. Our study shows that using WeChat or QQ to receive/read health-related posts had a statistically significant relationship with overall health information preferences. This empirical finding indicates that mHealth had a relationship with preferences for health information, and that mHealth can be a health information resource for Chinese patients with T2DM.

Implications

This study's findings have implications for mHealth developers, healthcare providers, and educators. Evidence indicates that patient-centered care will lead to empowerment for diabetes self-management (Rossi et al., 2015) if the healthcare services are personalized according to patients' needs and preferences. However, Chinese healthcare providers do not typically give their patients sufficient information about their health condition (Hua et al., 2013; Tang et al., 2002; Xie et al., 2015), resulting in a lack of diabetes-related information and self-management practices among the majority of Chinese patients (Zhou, Liao, Sun, & He, 2013).

Mobile apps can assist with disease management and promote health awareness and well-being. mHealth is bringing fundamental changes to healthcare practice through improved access to health information (Kart, 2016; Hartin et al., 2016) and participation in decision-making (Hartin et al., 2016; Riaz & Atreja, 2016). However, the quality of health information available on the Internet and on mobile devices is questionable (Antheunis et al., 2013; Eysenbach et al., 2002; Zhang, Sun, & Xie, 2015). Most online websites or mHealth apps do not supply adequate health information for patients with diabetes (Eysenbach et al., 2002; Nie et al., 2016; Smart & Burling, 2001; Weymann, Härter, & Dirmaier, 2015). Empirical results from this study show that mobile apps are an important resource for Chinese patients with T2DM while they are looking for health information. Thus, mHealth developers should design apps that provide a broad range of health information to empower patients. Healthcare providers and educators should work with mHealth developers to ensure that mHealth apps contain high quality information that meets the patients' preferences and needs.

LIMITATIONS AND FUTURE DIRECTIONS

Participants in this study were patients with T2DM from one general hospital in Southwest China, a region with the lowest education level compared with other regions in China. This population may not be representative of the general population of Chinese patients with T2DM or the populations of other regions in China. As such, this study's findings may not be generalized to the general T2DM patient population or the populations in other regions of China. Additional research is needed to address a broader range of participants, from different regions, in different clinics, and perhaps including type 1 diabetes patients.

Also, this study was a cross-sectional study that only reveals a snapshot of the view. Future research will benefit from a longitudinal design.

IMPLICATIONS OF THE STUDY

Implications for Research

This is the first study to explore preferences for health information and decision-making autonomy among Chinese patients with T2DM that analyzes both how mHealth is used by Chinese patients with T2DM, and the relationship between mHealth use and preference for types and amounts of health information and participation in decision-making autonomy. One previous study has explored Chinese cancer patients and family members' preferences for health information, but not decision-making preferences (Xie et al., 2015).

This study validates a Chinese-language instrument for examining information and decision-making preferences among Chinese patients with T2DM. The study findings have important implications for mHealth developers, healthcare providers, and educators. The study found that Chinese patients with T2DM wanted a wide range of health information and participation in decision-making. In particular, patients most desired information about laboratory tests and greater decision-making autonomy in choosing healthcare providers. These findings emphasize that for mHealth development, Chinese diabetes apps must include a wider range of health information to empower patients' diabetes self-management. The study suggests the importance of physician-patient interaction in healthcare practice. When addressing issues relating to specific health conditions, treatment, laboratory tests, CAM, psychosocial aspects, and healthcare providers, healthcare professionals should be sensitive to the patient's desire for a greater role in decision-making and tailor their communications accordingly.

Implications for Nursing Practice

The study has implications for nursing practice with regard to health education interventions and programs. This study shows that Chinese patients with T2DM wanted a wider range of health information and participation in decision-making; demographics significantly impacted preferences for health information and decision-making autonomy; and smartphone usage and access to social media were preferred methods in seeking health-related information. When nursing educators design health education interventions and programs, they need to pay attention to the patients' gender, education level, awareness of their health conditions, and how the patients perceived the severity of their health status.

Another important implication for nursing practice is the significance of improving interactions with patients. To promote patient-centered care, nurses and nurse practitioners must not only understand patient preferences for health information and decision-making autonomy, but also relate their practice to the perspective of the patient (Xie et al., 2013). The use of smartphones to access social media can offer nurses and nurse educators a means of helping patients monitor their condition, provide support in interpreting data for self-management, and supply individually tailored education plans (Goh et al., 2015; Lyles et al., 2011; Martínez-Pérez, de la Torre-Díez, & López-Coronado, 2013; van Vugt et al., 2013).

Implications for Policy

T2DM requires ongoing medical care and patient self-management (El-Gayar et al., 2013; Haas et al., 2013; van Vugt et al., 2013). For self-management to be effective, patients must have sufficient information regarding all aspects of their disease (Haas et al., 2013). mHealth has brought advanced mobile communications and technologies to patients with diabetes (Martínez-Pérez, de la Torre-Díez, & López-Coronado, 2013; van Vugt et al., 2013). It allows patients and healthcare providers to collaborate in managing patients' glucose, weight, and diet control; to provide direct, immediate feedback to the patient (Goh et al., 2015; Lyles et al., 2011; Wildevuur & Simonse, 2015); and to reduce hospitalizations, readmissions, and healthcare costs (Wildevuur & Simonse, 2015).

However, the literature review has indicated that younger patients find it easier to adopt and use new technologies. Our study shows that gender and education levels have an important impact on patients' preferences for health information and decision-making, smartphone usage in looking for health or medical information, and access to social media to seek health-related information. Policymakers need to consider gender and education levels when create the polies both to encourage male patients to seek information and participant in decision-making, and to meet the needs patients with low education levels. Thus, mobile technology policymakers need to consider the feasibility and usability of mobile technologies.

The quality of health information available on the Internet and through mobile devices is questionable (Antheunis et al., 2013; Eysenbach et al., 2002; Zhang et al., 2015). Perhaps policymakers should develop standards for the health information available via mobile technologies and then create policies that encourage the industry to monitor that health information and ensure that it meets those quality standards. Additionally, policymakers need to ensure that a broad range of diabetes-related information that meets acceptable quality standards is available in mobile apps and that it meets patients' preferences for information.

Of Chinese patients with T2DM, 50.5% had used a smartphone to look for health information online. 29% of them used a smartphone frequently to access the Internet, while 15.5% of them used a smartphone occasionally to access the Internet. Thus, healthcare and mHealth policymakers need to consider the population who did not have Internet access, did not have a smartphone, or had a smartphone but did not know how to use smartphones to access health information. These are important factors that policymakers need to consider carefully when developing policies.

Implications for Theory

The HIW framework uses a wide range of health information and decision-making to explain the relationship between the desire for different types of health information and different types of decision-making (Xie, 2009; Xie et al., 2011). The HIWQ measures preferences for seven types of health information and related decision-making. mHealth opens up new options for healthcare practice through improved access to health information and participation in decision-making. This empowers patients to become more actively involved in their own care, thereby encouraging greater levels of self-management. Thus the study framework, four key concepts of HIW, mHealth, empowerment, and self-management are interrelated and improve healthcare outcomes in distinct ways. This study empirically supports the effectiveness of the HIW theoretical framework in promoting a patient-centered approach to patients' preferences for health information and decision-making autonomy. mHealth has been used by Chinese patients with T2DM for seeking health-related information. This study's findings provide the evidence that smartphone use frequency and preferences for heath information and participation in decision-making are related to each other.

SUMMARY

The findings of the present study reveal that Chinese patients with T2DM wanted to have a wide range of health information and participation in decision-making. Chinese patients with T2DM wanted more information about laboratory tests, self-care, and treatment than about CAM, psychosocial aspects, specific health condition, and healthcare providers. They also wanted more participation in decision-making about healthcare providers and psychosocial aspects than other types of decision-making.

However, most current Chinese diabetes apps lacked any information about laboratory tests, CAM, and healthcare providers (Nie et al., 2016), suggesting a gap between the types of information patients wanted and those actually available in existing diabetes mobile apps. Our present study indicates that information on laboratory tests was the information wanted most by Chinese patients with T2DM, while factors like gender, general health status, and knowledge about their condition were associated with differences in preferences for information and participation in decision-making,. Across cultures, when examining patients' preferences for information and decision-making, it is important to look at a broad range of information and corresponding decision-making autonomy.

The study findings provide evidence that patients were interested in more health information but are not as much interested in participating in decision-making. Using HIWQ gives a broad range of preferences and parallel items on the information and decision-making preference scales, and measures a comprehensive set of patient preferences for health information and decision-making autonomy. This can improve patient-centered care by focusing on patient's preferences and needs.

The study showed that 53% of Chinese patients with T2DM occasionally accessed the Internet, 83% had smartphone, 58% used smartphones to access the Internet, 51% used smartphones to look for health or medical information online, 71% used smartphones to receive/read health related posts via WeChat or QQ apps, and 24% had at least one health-related app downloaded in their smartphone. Demographics (e.g., age, perceived severity of health condition), and how knowledgeable participants were about their health condition played an important role in smartphone use frequencies and in looking for health or medical information. Chinese patients with T2DM who used smartphones to take pictures, receive/send text messages, and access the Internet as well as to download health-related apps (e.g., exercise, fitness, or pedometer apps, diet, food, calorie counter apps, and weight apps) had much in common with American adults.

Smartphone use frequency had association with overall preferences for information wanted and participation in decision-making, the strength of which varied across the seven subscales of preferences for information and decision-making autonomy.

This study has important implications for healthcare practice, especially given the shift from disease-centered care to patient-centered care (Committee on Quality of Health Care in America, 2001). Therefore, healthcare professionals might want to consider different aspects of participation in order to better meet patients' preferences for decision-making. For example, Chinese healthcare providers might suggest that frequent smartphone users use WeChat/QQ to search for and receive or read health-related information about laboratory tests, self-care, and treatment, but they might not suggest this for infrequent smartphone users. However, healthcare providers might not need to provide as much CAM and psychosocial aspect information for patients who frequently use smartphones as for those who infrequently use smartphones. Because the quality of mHealth information on the Internet and in mobile apps is questionable (Antheunis et al., 2013; Eysenbach et al., 2002; Zhang et al., 2015), Chinese healthcare providers might need to know about existing diabetes apps themselves in order to suggest the quality apps to their patients.

mHealth is opening up new options for healthcare practice through improved access to health information (Kart, 2016; Hartin et al., 2016) and participation in decision-making (Hartin et al., 2016; Riaz & Atreja, 2016). This empowers patients to become more actively involved in their own care (Calvillo et al., 2013). Diabetes self-management can be more effective when patients receive sufficient information through mobile devices about their disease, treatment options, diet and nutrition, physical activities, safe use of medications, blood glucose monitoring, and compliance in following-up with healthcare providers (Hartin et al., 2016; Kart, 2016).

Appendix A – Health Survey – English

Health Questionnaire

Please fill out this questionnaire carefully. All of your responses will be treated confidentially. Any published document regarding these responses will not identify individuals. Thank you in advance for your help!

Part 1

1. **How long have you been diagnosed with diabetes?** Year(s): _________ and Month(s): _____________

2. **How severe do you think this health condition is? Please circle ONE**:

☐ ☐ ☐ ☐ ☐

Not severe at all   A little severe   Moderately severe   Very severe   Extremely severe

3. **How knowledgeable do you think you are about this health condition? Please circle ONE:**

☐ ☐ ☐ ☐ ☐

Not at all knowledgeable   A little knowledgeable   Moderately knowledgeable   Very knowledgeable   Extremely knowledgeable

4. **Overall, how much information would you like to have about this health condition? Please circle ONE:**

☐ ☐ ☐ ☐ ☐

None   A little   Some   Most   All

5. Please circle the appropriate number in **each row** to indicate how much information you would like to have about each of the following areas related to this specific health condition:

How much information would you like to have?					
1. Information about what type of this health condition (e.g., Type 1, Type 2, other types)	None	A little	Some	Most	All
2. Information about how severe this health condition is	None	A little	Some	Most	All
3. Information explaining why further referral is necessary	None	A little	Some	Most	All
4. Information about whether this health condition is contagious or genetic	None	A little	Some	Most	All
5. Information explaining how a medication may help to treat this health condition	None	A little	Some	Most	All
6. Information about the specific drug(s) prescribed (e.g., amount, oral or injection, how often)	None	A little	Some	Most	All
7. Information about changing medications (e.g., whether need to change and reason for the change)	None	A little	Some	Most	All
8. Information about benefits and risks of different laboratory tests (e.g., A1C, fasting blood glucose, 2-hour post-prandial glucose test, cholesterol)	None	A little	Some	Most	All
9. Information about how to prepare for laboratory tests (e.g., fasting or not)	None	A little	Some	Most	All
10. Information about interpretations of the results of laboratory tests (e.g., normal or abnormal)	None	A little	Some	Most	All
11. Information about how this health condition may affect my work/personal life (e.g., smoking, alcohol, hobbies)	None	A little	Some	Most	All
12. Information about how to check blood glucose at home and how often	None	A little	Some	Most	All
13. Information about how to take the prescribed medication (e.g., injecting insulin or taking oral medication)	None	A little	Some	Most	All
14. Information about how to adjust my diet to eat healthier	None	A little	Some	Most	All
15. Information about how to engage in physical activities	None	A little	Some	Most	All
16. Information about when I should contact a healthcare provider	None	A little	Some	Most	All
17. Information about the benefits and risks of using complementary/alternative medicine (e.g., Chinese	None	A little	Some	Most	All

medicine, herbs, acupuncture) alone versus in combination with standard medicine					
18. Information about <u>when</u> to get complementary/alternative medicine (e.g., Chinese medicine)	None	A little	Some	Most	All
19. Information about <u>where</u> to get complementary/alternative medicine (e.g., Chinese medicine)	None	A little	Some	Most	All
20. Information about support groups where I can talk with other people in similar situations	None	A little	Some	Most	All
21. Information about how the treatment may affect feelings about myself	None	A little	Some	Most	All
22. Information about how to involve my family in dealing with feelings about this health condition	None	A little	Some	Most	All
23. Information about the credentials, experiences, or reputations of a particular medical facility	None	A little	Some	Most	All
24. Information about the credentials, experiences, or reputations of a particular medical specialist	None	A little	Some	Most	All

Part 2

1. Overall, who do you think should make the decision related to this specific health condition? Please circle ONE:

☐ ☐ ☐ ☐ ☐

The doctor alone   Mostly the doctor   The Doctor and myself equally   Mostly myself   Myself alone

2. Please circle the appropriate number in **<u>each row</u>** to indicate **<u>*who* you think should make the decision in each of the following areas:</u>**

Who do you think should make the decision?					
1. Decision regarding what type this health condition is (e.g., type 1, type 2, other types)	The doctor alone	Mostly the doctor	The doctor and myself equally	Mostly myself	Myself alone
2. Decision regarding how severe this health condition is	The doctor	Mostly the	The doctor and myself	Mostly myself	Myself alone

	alone	doctor	equally		
3. Decision regarding whether further referral is necessary	The doctor alone	Mostly the doctor	The doctor and myself equally	Mostly myself	Myself alone
4. Decision regarding whether this health condition is contagious or genetic	The doctor alone	Mostly the doctor	The doctor and myself equally	Mostly myself	Myself alone
5. Decision regarding whether to use a medication	The doctor alone	Mostly the doctor	The doctor and myself equally	Mostly myself	Myself alone
6. Decision regarding which specific drugs(s) to use (e.g., amount, oral or injection, how often)	The doctor alone	Mostly the doctor	The doctor and myself equally	Mostly myself	Myself alone
7. Decision regarding whether to change medications (e.g., whether need to change and reason for the change)	The doctor alone	Mostly the doctor	The doctor and myself equally	Mostly myself	Myself alone
8. Decision regarding what laboratory test(s) to use (e.g., A1C, 2-hour post-prandial glucose test, cholesterol)	The doctor alone	Mostly the doctor	The doctor and myself equally	Mostly myself	Myself alone
9. Decision regarding how to prepare for a given laboratory test (e.g., fasting or not)	The doctor alone	Mostly the doctor	The doctor and myself equally	Mostly myself	Myself alone
10. Decision regarding how to interpret the results of a given laboratory test (e.g., normal or abnormal)	The doctor alone	Mostly the doctor	The doctor and myself equally	Mostly myself	Myself alone
11. Decision regarding how to adapt to this health condition at work/ in personal life (e.g., smoking, alcohol, hobbies)	The doctor alone	Mostly the doctor	The doctor and myself equally	Mostly myself	Myself alone
12. Decision regarding how to check blood glucose at home and how often	The doctor alone	Mostly the doctor	The doctor and myself equally	Mostly myself	Myself alone
13. Decision regarding how to take the prescribed medications (e.g., injecting insulin or taking oral medication)	The doctor alone	Mostly the doctor	The doctor and myself equally	Mostly myself	Myself alone
14. Decision regarding how to adjust my diet to eat healthier	The doctor alone	Mostly the doctor	The doctor and myself equally	Mostly myself	Myself alone

15. Decision regarding how to engage in physical activities	The doctor alone	Mostly the doctor	The doctor and myself equally	Mostly myself	Myself alone
16. Decision regarding when I should contact a healthcare provider	The doctor alone	Mostly the doctor	The doctor and myself equally	Mostly myself	Myself alone
17. Decision regarding whether to use complementary/ alternative medicine (e.g., Chinese Medicine, Chinese herbs, acupuncture) alone versus in combination with standard medicine	The doctor alone	Mostly the doctor	The doctor and myself equally	Mostly myself	Myself alone
18. Decision regarding when to get complementary/ alternative medicine	The doctor alone	Mostly the doctor	The doctor and myself equally	Mostly myself	Myself alone
19. Decision regarding where to get complementary / alternative medicine	The doctor alone	Mostly the doctor	The doctor and myself equally	Mostly myself	Myself alone
20. Decision regarding whether to join support groups to talk with other people in similar situations	The doctor alone	Mostly the doctor	The doctor and myself equally	Mostly myself	Myself alone
21. Decision regarding how to deal with feelings about myself as a result of the treatment	The doctor alone	Mostly the doctor	The doctor and myself equally	Mostly myself	Myself alone
22. Decision regarding how to involve my family in dealing with feelings about this health condition	The doctor alone	Mostly the doctor	The doctor and myself equally	Mostly myself	Myself alone
23. Decision regarding whether to go a particular medical facility	The doctor alone	Mostly the doctor	The doctor and myself equally	Mostly myself	Myself alone
24. Decision regarding whether to see a particular medical specialist	The doctor alone	Mostly the doctor	The doctor and myself equally	Mostly myself	Myself alone

Part 3

1. How often do you use the Internet? Please circle ONE.

☐ ☐ ☐ ☐ ☐

Never Rarely Occasionally
Frequently Very Frequently

2. **How often do you send or receive email? Please circle ONE.**

☐ ☐ ☐ ☐ ☐

Never Rarely Occasionally Frequently
Very Frequently

3. **How often do you access the Internet on a cellphone, tablet or other mobile handheld device? Please circle ONE.**

☐ ☐ ☐ ☐ ☐

Never Rarely Occasionally Frequently
Very Frequently

4. **How long have you used a smartphone? Please skip this question if you don't have a smartphone.**
   - ☐Never
   - ☐Less than one year (< 1 year)
   - ☐More than one year, less than three years (1-3 year)
   - ☐More than three years, less than five years (3-5 year)
   - ☐More than five years, less than ten years (5-10 year)
   - ☐More than ten years (>10 years)

5. **Some cellphones are called "smartphones" because of certain features they have. Is your cellphone a smartphone, such as iPhone, Android, Hua Wei, Xiao Mi or are you not sure? Please circle ONE**
   - ☐Yes, smartphone
   - ☐No, not a smartphone
   - ☐Not sure/Don't know

6. **How often do you use a smart phone? Please skip this question if you don't have a smartphone.**
   - ☐Never
   - ☐Less than once a month
   - ☐More than once a month
   - ☐Once a week
   - ☐Every 2-3 days
   - ☐Every day

7. **Do you receive any TEXT updates or alerts about health or medical issues, such as from your doctors or nurses?**
   ☐Yes ☐No ☐Don't Know

8. **On you cellphone, do you have any software applications that help you track or manage your health?**
   ☐Yes ☐No ☐Don't Know

9. **Please tell me if you ever use your cellphone to do any of the following things:**

	Yes	**No**	**Don't know**
Send or receive email			
Send or receive text messages			
Take a picture			
Access the Internet			
Look for health or medical information online			
Check your bank account balance or do any online banking			
Receive/read health-related posts via your cell phone apps that support social media, e.g., WeChat, QQ			
Received/read health-related information via mobile health apps on your cell phone, e.g., Welltang.			

10. **What kind of health apps do you currently have on your cellphone?**
    ☐Exercise, fitness, pedometer
    ☐Monitor heart rate
    ☐Diet, food, calorie counter
    ☐Weight
    ☐Period or menstrual cycle
    ☐Blood pressure
    ☐Pregnancy
    ☐Blood sugar or diabetes
    ☐Medication management (e.g., tracking, reminder, alerts, etc.)
    ☐Mood
    ☐Sleep

☐Don't know

Part 4

1. **Age: ___________________**

2. **Gender** ☐Female ☐Male

3. **What is your current marital status? Please circle ONE.**
   ☐Married
   ☐Single
   ☐Separated
   ☐Divorced
   ☐Widowed

4. **In general, would you say your health is: (Please circle ONE)**
   ☐Poor
   ☐Fair
   ☐Good
   ☐Very good
   ☐Excellent

5. **Which category best describes your annual household income compared with other families in the region? Please circle ONE.**
   ☐Very low
   ☐Low
   ☐Medium
   ☐High
   ☐Very high
   ☐Don't' know
6. **What is your highest level of education? Please circle ONE.**
   ☐No formal education
   ☐Less than high school graduate
   ☐High School graduate
   ☐Vocational training
   ☐Associate's degree / Technical school
   ☐Bachelor's degree

☐Master's degree
☐Doctoral degree
☐Other: ______________________

7. **Do you have health insurance:** ☐Yes ☐No

8. **What is your employment status?**
☐Full-time ☐Part-time ☐Unemployed ☐ Retired

Thank You!

Appendix B – Health Survey – Chinese

健康问卷

这是一项有关健康信息需求的研究。本研究将会对您的所有回答严格保密，任何与此研究有关的出版刊物绝不会透露您的个人信息。请仔细回答这份问卷。真诚感谢您的合作！

第一部分

1．您被诊断为患糖尿病有多久了？__________年________月

2．您个人认为这个疾病有多严重？请在相应的选项上打勾。

□	□	□	□	□
不严重	有点严重	中等严重	很严重	极其严重

3．您认为您目前了解多少关于这个疾病的知识？请在相应的选项上打勾。

□	□	□	□	□
不了解	了解一点	中等了解	了解很多	非常了解

4．整体上说，您希望了解多少关于这个疾病的信息？请在相应的选项上打勾。

□	□	□	□	□
无	一点	部分	大部分	全部

5. 请在下表的每一行中圈出一个相应的选项来表示您对以下健康信息的了解

您希望了解多少关于以下方面的信息？					
1. 关于这个疾病是哪一型的信息（如：**1**型，**2**型，其它类型）	无	一点	部分	大部分	全部
2. 关于这个疾病严重程度的信息	无	一点	部分	大部分	全部
3.关于解释转诊是否必要的信息	无	一点	部分	大部分	全部
4. 关于这个疾病是传染性或是遗传性的信息	无	一点	部分	大部分	全部
5. 关于解释药物是如何治疗这个疾病的信息	无	一点	部分	大部分	全部
6. 关于处方上所开的特定药品的信息（如：剂量，口服或注射，服用频率）	无	一点	部分	大部分	全部
7. 关于更换药品的信息 （如**:** 是否需要换药，换药的原因）	无	一点	部分	大部分	全部
8. 关于不同化验检查（如**: A1C**，空腹血糖，饭后**2**小时血糖检测，胆固醇**)**的益处与风险的信息	无	一点	部分	大部分	全部
9. 关于如何准备化验检查（如：禁食或不禁食）的信息	无	一点	部分	大部分	全部

10.关于解释化验检查结果（如：正常或不正常)的信息	无	一点	部分	大部分	全部
11. 关于这个疾病对我的工作或个人生活造成影响的信息 (如：吸烟、饮酒、兴趣爱好)	无	一点	部分	大部分	全部
12.关于如何和多频繁在家检测血糖的信息	无	一点	部分	大部分	全部
13. 关于如何用处方药物 （如：注射胰岛素或服用口服药）的信息	无	一点	部分	大部分	全部
14.关于如何把我的饮食调整得更健康的信息	无	一点	部分	大部分	全部
15.关于如何参与体育活动的信息	无	一点	部分	大部分	全部
16. 关于什么时候我应该与医务人员联系的信息	无	一点	部分	大部分	全部
17.关于单独使用补充/替代疗法 （如：中医，中药等）或将其与常规疗法结合分别有何益处与风险的信息	无	一点	部分	大部分	全部
18.关于何时采用补充/替代疗法 （如：中医，中药等）的信息	无	一点	部分	大部分	全部
19.关于何处寻求补充/替代疗法的 （如：中医，中药等）信息	无	一点	部分	大部分	全部
20.关于病友会和与其他相同病的病友交流的信息	无	一点	部分	大部分	全部

21.关于这种治疗会如何影响我对自己的感受 （如：心理，精神，情绪方面的感受)的信息	无	一点	部分	大部分	全部
22.关于如何与我的家人一起应对这个疾病带来的困扰（如：心理，精神，情绪方面的困扰)的信息	无	一点	部分	大部分	全部
23.关于医院的资历、经验或声誉的信息	无	一点	部分	大部分	全部
24.关于某位专家的资历、经验或声誉的信息	无	一点	部分	大部分	全部

第二部分

1．整体上说，您认为与这个疾病相关的决定应该由谁来做？请在相应的选项上打勾。

☐	☐	☐	☐	☐
医生决定	大部分由医生决定	医生和病人各半	大部分由病人决定	病人决定

2．请在下表的每一行中圈出一个相应的选项来表示您认为关于这个疾病的这些相关方面，应该 由谁来做出决定？

您认为应该由谁来做出决定？					
1.关于这个疾病是哪型（如：1型，2型，其它类型）的决定	医生单独决定	大部分由医生决定	医生和病人各半	大部分由病人决定	病人单独决定
2. 关于这个疾病严重程度的决定	医生单独决定	大部分由医生决定	医生和病人各半	大部分由病人决定	病人单独决定
3. 关于是否需要转诊的决定	医生单独决定	大部分由医生决定	医生和病人各半	大部分由病人决定	病人单独决定
4. 关于这个疾病是否会遗传或传染的决定	医生单独决定	大部分由医生决定	医生和病人各半	大部分由病人决定	病人单独决定
5. 关于是否使用药物治疗的决定	医生单独决定	大部分由医生决定	医生和病人各半	大部分由病人决定	病人单独决定
6. 关于使用哪种特定药品（如：剂量，口服或注射，服用频率）的决定	医生单独决定	大部分由医生决定	医生和病人各半	大部分由病人决定	病人单独决定

7. 关于是否更换药物的决定(如：是否需要换药，换药的原因)	医生单独决定	大部分由医生决定	医生和病人各半	大部分由病人决定	病人单独决定
8. 关于进行什么化验检查（如: A1C，空腹血糖，饭后2小时-血糖检测，胆固醇）的决定	医生单独决定	大部分由医生决定	医生和病人各半	大部分由病人决定	病人单独决定
9. 关于如何准备实验室化验检查（如：禁食或不禁食）的决定	医生单独决定	大部分由医生决定	医生和病人各半	大部分由病人决定	病人单独决定
10. 关于怎样解释化验检查结果（如: 正常或不正常) 的决定	医生单独决定	大部分由医生决定	医生和病人各半	大部分由病人决定	病人单独决定
11.关于怎么调整这个疾病到我的日常工作或个人生活里 (例如: 吸烟、饮酒、兴趣爱好) 的决定	医生单独决定	大部分由医生决定	医生和病人各半	大部分由病人决定	病人单独决定
12. 关于如何和多频繁在家检测血糖的决定	医生单独决定	大部分由医生决定	医生和病人各半	大部分由病人决定	病人单独决定
13. 关于如何用处方药物 （如：注射胰岛素或服用口服药）的决定	医生单独决定	大部分由医生决定	医生和病人各半	大部分由病人决定	病人单独决定
14.关于如何把我的饮食调整得更健康的决定	医生单独决定	大部分由医生决定	医生和病人各半	大部分由病人决定	病人单独决定
15. 关于如何参与体育活动的决定	医生单独决定	大部分由医生决定	医生和病人各半	大部分由病人决定	病人单独决定
16. 关于什么时候我应该与医务人员联系的决定	医生单独决定	大部分由医生决定	医生和病人各半	大部分由病人	病人单独决定

				决定	
17. 关于是否单独使用补充/替代疗法（如:中医，中药等）或将其与常规疗法结合分别使用的决定	医生单独决定	大部分由医生决定	医生和病人各半	大部分由病人决定	病人单独决定
18. 关于何时采用补充/替代疗法(如:中医,中药等）的决定	医生单独决定	大部分由医生决定	医生和病人各半	大部分由病人决定	病人单独决定
19. 关于何处寻求补充/替代疗法（如:中医，中药等）的决定	医生单独决定	大部分由医生决定	医生和病人各半	大部分由病人决定	病人单独决定
20. 关于是否加入病友会和可与其他相同病病友交流的决定	医生单独决定	大部分由医生决定	医生和病人各半	大部分由病人决定	病人单独决定
21. 关于这种治疗会如何影响我对自己的感受（如：心理, 精神, 情绪方面的感受)的决定	医生单独决定	大部分由医生决定	医生和病人各半	大部分由病人决定	病人单独决定
22. 关于如何与我的家人一起应对这个疾病带来的困扰（如：心理, 精神, 情绪方面的感受) 的决定	医生单独决定	大部分由医生决定	医生和病人各半	大部分由病人决定	病人单独决定
23. 关于是否选择这家医院的决定	医生单独决定	大部分由医生决定	医生和病人各半	大部分由病人决定	病人单独决定
24. 关于是否选择某位医学专家的决定	医生单独决定	大部分由医生决定	医生和病人各半	大部分由病人决定	病人单独决定

第三部分

1. 您使用互联网多频繁？请在相应的选项上打勾。

☐ 从不	☐ 极少	☐ 偶尔	☐ 频繁地	☐ 非常频繁

2. 您发送或接收电子邮件多频繁？请在相应的选项上打勾。

☐ 从不	☐ 极少	☐ 偶尔	☐ 频繁地	☐ 非常频繁

3. 您用手机、平板电脑或其他移动手持设备上互联网多频繁？请在相应的选项上打勾。

☐ 从不	☐ 极少	☐ 偶尔	☐ 频繁地	☐ 非常频繁

4. 您用智能手机多久了？请在相应的选项上打勾。如果您没有智能手机，请跳过这题。

- ☐ 从没用过
- ☐ 用了不到一年 （<1 年）
- ☐ 多于一年，少于三年（1-3 年）
- ☐ 多于三年，少于五年（3-5 年）
- ☐ 多于五年，少于十年（5-10 年）
- ☐ 多于十年（>10 年）

5. 有些手机因为特定的功能被称为智能手机。您的手机是智能手机吗？比如：苹果手机，安卓手机，华为手机，小米手机或您不知道？请在相应的选项上打勾。

☐ 是，智能手机　　☐ 否，不是智能手机　　☐ 不确定/不知道

6. 您使用智能手机有多频繁？请在相应的选项上打勾。如果您没有智能手机请略过此题。

- ☐ 从没用过

- □ 每月不到一次
- □ 每月多于一次
- □ 每周一次
- □ 每 2-3 天
- □ 每天

7. 您是否收到关于任何健康或医疗问题的短信（新情况或警报）？比如从您的医生或护士那里。

□ 是　　□ 否　　□ 不知道

8. 您的手机里是否有能帮您追踪或管理健康的应用程序?

□ 是　　□ 否　　□ 不知道

9. 请告诉我您是否用您的手机做以下任何的事情：

	是	否	不知道
发送或接收电子邮件			
发送或接收短信			
拍照			
上网			
上网寻找健康或医疗信息			
上网检查银行账户的余额或做任何网上银行的业务			
通过手机里社交媒体的应用程序（比如微信，QQ）接收/阅读与健康相关的信息			
通过手机里移动健康应用程序（比如微糖）接收/阅读与健康相关的信息			

10. 目前您的手机里有什么种类的健康应用程序?
- □ 运动,健身,计步器
- □ 心率监控
- □ 饮食,食品,卡路里计数器
- □ 体重
- □ 月经周期

- □ 血压
- □ 怀孕
- □ 血糖或糖尿病
- □ 药物管理 （如：跟踪、提醒，警报,等）
- □ 情绪
- □ 睡眠
- □ 不知道

第四部分

1. 年龄: ______________

2. 性别: □**女** □**男**

3. 您目前的婚姻状况是什么？请在相应的选项上打勾。

□	□	□	□	□
已婚	未婚	分居	离婚	丧偶

4. 整体上说，您认为您的健康状况是？请在相应的选项上打勾。

□	□	□	□	□
很差	一般	好	很好	极好

5. 您认为您的家庭收入状况在当地与其他家庭比属于哪一档？请在相应的选项上打勾。

□	□	□	□	□	□
极低	低	中等	高	极高	不清楚

6. 您受的最高教育程度是什么？请在相应的选项上打勾。

- □ 没有受过正式的教育
- □ 不到高中毕业
- □ 高中毕业
- □ 职业培训
- □ 大专/技校
- □ 大学本科
- □ 硕士
- □ 博士
- □ 其它 (请注明:________)

7. 您是否有医疗保险? □ 是 □ 否

8. 您目前的工作情况是什么？请在相应的选项上打勾。

□ 全职 □ 兼职 □ 无业 □ 退休

非常感谢您的参与！

Appendix C – Institutional Review Board Approval Letter

OFFICE OF RESEARCH SUPPORT

THE UNIVERSITY OF TEXAS AT AUSTIN

P.O. Box 7426, Austin, Texas 78713 · Mail Code A3200
(512) 471-8871 · FAX (512) 471-8873

FWA # 00002030

Date: 02/17/17

PI: Ronghong Nie

Dept: Nursing

Title: Health Information and Decision-Making Preference Survey
and implication of mHealth Survey

Re: IRB Amendment Approval for Protocol Number 2016-03-0056

Dear Ronghong Nie:

In accordance with the Federal Regulations for review of research studies, the Institutional Review Board (IRB) reviewed your requested amendment to the above referenced protocol and found that it met the requirements for approval.

Approval for your study expires on 04/14/2017. *Expires 12 a.m. [midnight] of this date.*

The following requested changes were approved:
Titled changed from "Health Information and Decision-Making Preference Survey". Added measures (14 questions added to survey).

☐ Continue to use the original approved consent form(s).
☒ Use the attached approved informed consent document(s).
☐ You have been granted a Waiver of Documentation of Consent according to 45 CFR 46.117 and/or 21 CFR 56.109(c)(1).
☐ You have been granted a Waiver of Informed Consent according to 45 CFR 46.116(d).

Responsibilities of the Principal Investigator:

1. Report immediately to the IRB any unanticipated problems.

2. Submit for review and approval by the IRB all modifications to the protocol or consent form(s). Ensure the proposed changes in the approved research are not applied without prior IRB review and approval, except when necessary to eliminate apparent immediate hazards to the subject. Changes in approved research implemented without IRB review and approval initiated to eliminate apparent immediate hazards to the subject must be promptly reported to the IRB, and will be reviewed under the unanticipated problems policy to determine whether the change was consistent with ensuring the subjects continued welfare.

3. Report any significant findings that become known in the course of the research that might affect the willingness of subjects to continue to participate.

4. Ensure that only persons formally approved by the IRB enroll subjects.

5. Use only a currently approved consent form, if applicable.
   Note: Approval periods are for 12 months or less.

6. Protect the confidentiality of all persons and personally identifiable data, and train your staff and collaborators on policies and procedures for ensuring the privacy and confidentiality of subjects and their information.

7. Submit a Continuing Review Application for continuing review by the IRB. Federal regulations require IRB review of on-going projects no less than once a year a reminder letter will be sent to you two months before your expiration date. If a reminder is not received from Office of Research Support (ORS) about your upcoming continuing review, it is still the primary responsibility of the Principal Investigator not to conduct research activities on or after the expiration date. The Continuing Review Application must be submitted, reviewed and approved, before the expiration date.

8. Upon completion of the research study, a Closure Report must be submitted to the ORS.

9. Include the IRB study number on all future correspondence relating to this protocol.

If you have any questions contact the ORS by phone at (512) 471-8871 or via email at orsc@uts.cc.utexas.edu.

Sincerely,

James P. Wilson

James Wilson, Ph.D.
Institutional Review Board Chair

Appendix D – Verbal Consent – English

Title: Preferences for Health Information and Decision-making in Chinese Persons with Type 2 Diabetes and mHealth implication.

Introduction: This form is to provide you information that may affect your decision as to whether or not to participate in this study. The principal investigator will answer any of your questions. Read the information below and ask any questions you might have before deciding whether or not to take part.

Purpose of the Study: The purpose of this study is to explore and understand about your preferences for health information and participation in decision-making, and to explore if mHealth can be used and facilitated in Chinese patients with type 2 diabetes self-management. The results of this study will enhance patients with diabetes self-management.

What will you to be asked to do?
You will be asked to answer a questionnaire carefully, and give the best answers to each question. This will take approximately 30 - 35 minutes.

What are the risks involved in this study?
The risks are no greater than those encountered in everyday life.

What are the possible benefits of this study?
The possible benefits of participation may include helping the researchers learn about what your preferences for health information and participation in decision-making you may want, and if mHealth can assist your diabetes self-management. It may lead to improved practices.

Do you have to participate?
No, you don't have to participate. Your participation is voluntary. You may decide not to participate at all or, if you start the study, you may withdraw at any time. Withdrawal or refusing to participate will not affect your relationship with The University of Texas at Austin; also withdrawal from the study will not affect your relationship with Sichuan Academy of Medical Science/Sichuan Provincial People's Hospital, the Endocrinology Department.

Will there be any compensation?
No, there is no compensation for participating in this study.

What are my confidentiality or privacy protections when participating in this research study?

This study is confidential. Participation in this research project is completely voluntary. We will do our best to protect your privacy and confidentiality. To ensure your confidentiality, no personally identifying information will be collected. All of the survey form will be locked in filing cabinets in the principal investigator's office or on password-protected computers used by project personnel. After completion of the study, the data will be kept for 5 years. During the 5-year period, the data may be used for future research or made available to other researchers for research purposes upon written request to the principal investigator. After this 5-year period, all data will be destroyed physically or electronically. When we write a report or article about this research project, your identity will be protected to the maximum extent possible.

Whom to contact with questions about the study?

Prior, during or after your participation you can contact the principal investigator Lisa Nie at 512-250-9989 or send an email to lisanie@utexas.edu**.**

Whom to contact with questions concerning your rights as a research participant?

This study has been reviewed and approved by The University Institutional Review Board and the study number is 2016-03-0056. For questions about your rights or any dissatisfaction with any part of this survey study, you can contact, anonymously if you wish, the Institutional Review Board by phone at (512) 471-8871 or email at orsc@uts.cc.utexas.edu.

This study is eligible for a waiver of documentation of informed consent on the grounds that it is no more than minimal risk and the activities would not require consent outside of the research context.

Verbal Consent

You have been informed about this study's purpose, procedures, possible benefits and risks, and you have received a copy of this form. You have been given the opportunity to ask questions and you have been told that you can ask other questions at any time. You voluntarily agree to participate in this study with your verbal consent.

Appendix E – Verbal Consent – Chinese

口头同意书

标题:
个人倾向的健康信息和决策的研究和使用互联网的结果

介绍:
本同意书的用途是为您提供信息，以便您决定是否要参加这项研究。研究人员将会回答您的任何问题。在决定是否参加以前请您阅读下面的信息并问任何问题.

本研究的目的:
这项研究的目的是要了解您对有关健康信息和参与健康决策的想法和使用互联网是否可以帮助您。您的回答将帮助我们更好地提高糖尿病患者的自我管理。

您要被问些什么?
您需要仔细阅读问卷并仔细回答每一个问题，给出每个问题的最佳解答。这个过程将需要大约 30 - 35 分钟。

有什么风险涉及在这项研究中?
这项研究没有可预见的风险。

这项研究可能有哪些好处?
您的参与可能帮助研究人员了解您对有关健康信息和参与健康决策的想法和使用互联网是否可以帮助您。可帮助医护人员更好的为您服务。

您必须要参与此研究吗？
不，您不是必须参与。您的参与是完全自愿的。您可以决定不参加；如果您已开始参与这项研究，您也可以随时退出。撤回或拒绝参加此研究将不会影响您与得克萨斯大学奥斯汀分校的关系和您院的关系。

会有什么补偿吗?
没有。在结束时候，我们会给您一个小礼品将感谢您参与这项研究。

我参加这项问卷调查的机密或隐私权有什么保护吗?
这项研究是完全匿名和保密的。 参与这一研究项目是完全自愿的。 我们将尽最大努力保护您的隐私。我们不会收集任何可以识别个人的信息。所有的调查表都将被锁在主要研究人员办公室的文件柜里或者有密码保护的计算机里。研究完成后, 数据将被保留 5 年。 在这 5 年期间内，数据可能会在未来的研究中被使用或提供给其他的研究人员用于研究的目

地。 5 年之后，所有数据都将被销毁。当我们发表关于此研究的报告或文章时，您的身份将会在最大程度内得到保护。

若有与问卷调查的问题有联系人的方式吗?
您参与之前、期间或之后您可以联系主要研究人员 Lisa 聂 512-250-9989 或发送电子邮件给 lisanie@utexas.edu

做为一个参与问卷调查的参与者若有权利问题有联系人的方式吗?
若有关于您的人权或有任何对本研究不满意的问题,您可以匿名的途径向审查委员会举报，电话是(512) 471-8871 或发送电子邮件 orsc@uts.cc.utexas.edu。

口头同意书—您已了解此项研究的目的、程序、可能的收益和风险，您已收到此说明书。您已经被告知在任何时间您都有机会提出问题并可以询问其它问题。 您口头同意自愿参加这项研究。

References

Adams, J. R., Drake, R. E., Wolford, G. L. (2007). Shared decision-making preferences of people with severe mental illness. *Psychiatric Services,* 58(9), 1219-1221.

Adams, R. (2008). Empowerment, participation and social work (4th ed.). New York: Palgrave Macmillan.

Adibi, S. (2015). Mobile health: A technology road map: Springer.

Aikens, J. E., Rosland, A.-M., & Piette, J. D. (2015). Improvements in illness self-management and psychological distress associated with telemonitoring support for adults with diabetes. *Primary Care Diabetes,* 9(2), 127-134. http://dx.doi.org/10.1016/j.pcd.2014.06.003

Aikens, J. E., Zivin, K., Trivedi, R., & Piette, J. D. (2014). Diabetes self-management support using mHealth and enhanced informal caregiving. *Journal of Diabetes and Its Complications,* 28(2), 171-176. http://dx.doi.org/10.1016/j.jdiacomp.2013.11.008

American Diabetes Association. (2015). Standards of medical care in diabetes—2015. *Diabetes Care,* 38(Suppl. 1). http://dx.doi.org/10.2337/dc15-s001-s018

Anderson, R. M., & Funnell, M. M. (2002). Using the empowerment approach to help patients change behavior. In B. Anderson & R. Rubin (Eds.), Practical psychology for diabetes clinicians: How to deal with the key behavioral issues faced by Patients and healthcare teams (2nd ed., pp. 3-12). *American Diabetes Association.*

Antheunis, M., Tates, K., & Nieboer, T. (2013). Patients’ and health professionals’ use of social media in health care: Motives, barriers and expectations. *Patient Education and Counseling,* 92(3), 426-431. http://dx.doi.org/10.1016/j.pec.2013.06.020

Arnhold, M., Quade, M., & Kirch, W. (2014). Mobile applications for diabetics: A systematic review and expert-based usability evaluation considering the special requirements of diabetes patients age 50 years or older. *Journal of Medical Internet Research,* 16(4), e104. http://dx.doi.org/10.2196/jmir.2968

Arora, S., Peters, A. L., Burner, E., Lam, C. N., & Menchine, M. (2014). Trial to examine text message-based mHealth in emergency department patients with diabetes (TExT-MED): A randomized controlled trial. *Annals of Emergency Medicine,* 63(6), 745-754. http://dx.doi.org/10.1016/j.annemergmed.2013.10.012

Årsand, E., Tatara, N., Østengen, G., & Hartvigsen, G. (2010). Mobile phone-based self-management tools for type 2 diabetes: The Few Touch application. *Journal of Diabetes Science and Technology*, 4(2), 328-336. http://dx.doi.org/10.1177/193229681000400213

Aujoulat, I., d’Hoore, W., & Deccache, A. (2007). Patient empowerment in theory and practice: Polysemy or cacophony? *Patient Education and Counseling,* 66(1), 13-20. http://dx.doi.org/10.1016/j.pec.2006.09.008

Beatty, P. C., Willis, G. B. (2007). Research synthesis: The practice of cognitive interviewing. *Public Opinion Quarterly,* 71(2), 287-311. http://dx.doi.org/10.1093/poq/nfm006

Bell, A. C., Ge, K., & Popkin, B. M. (2002). The road to obesity or the path to prevention: Motorized transportation and obesity in China. *Obesity,* 10(4), 277-283. http://dx.doi.org/10.1038/oby.2002.38

Boulos, M. N. K., Brewer, A. C., Karimkhani, C., Buller, D. B., & Dellavalle, R. P. (2014). Mobile medical and health apps: State of the art, concerns, regulatory control and certification. *Online Journal Public Health Informatics,* 5(3), e229. http://dx.doi.org/10.5210/ojphi.v5i3.4814

Bravo, P., Edwards, A., Barr, P. J., Scholl, I., Elwyn, G., & McAllister, M. (2015). Conceptualising patient empowerment: A mixed methods study. *BMC Health Research,* 15, 252. http://dx.doi.org/10.1186/s12913-015-0907-z

Brennan, P. F., & Strombom, I. (1998). Improving health care by understanding patient preferences. *Journal of the American Medical Informatics Association,* 5(3), 257-262.

Brown, S. A. (1988). Effects of educational interventions in diabetes care: A meta-analysis of findings. *Nursing Research,* 37(4), 223-230.

Brown, S. A. (1992). Meta-analysis of diabetes patient education research: Variations in intervention effects across studies. *Research in Nursing & Health,* 15(6), 409-419. http://dx.doi.org/10.1002/nur.4770150603

Brown, S. A., Becker, B. J., Garcia, A. A., Brown, A., & Ramirez, G. (2015). Model-driven meta-analyses for informing health care: A diabetes meta-analysis as an exemplar. *Western Journal of Nursing Research,* 37(4), 517-535. http://dx.doi.org/10.1177/0193945914548229

Buhi, E. R., Trudnak, T. E., Martinasek, M. P., Oberne, A. B., Fuhrmann, H. J., & McDermott, R. J. (2012). Mobile phone-based behavioral interventions for health: A systematic review. *Health Education Journal,* 72(5), 564-583. http://dx.doi.org/10.1177/0017896912452071

Burner, E. R., Menchine, M. D., Kubicek, K.., Robles, M., & Arora, S. (2014). Perceptions of successful cues to action and opportunities to augment behavioral triggers in diabetes self-management: Qualitative analysis of a mobile intervention for low-income Latinos with diabetes. *Journal of Medical Internet Research*, 16(1), e25. http://dx.doi.org/10.2196/jmir.2881

Burner, E. [R.], Menchine, M. [D.], Taylor, E., Arora, S. (2013). Gender differences in diabetes self-management: A mixed-methods analysis of a mobile health intervention for inner-city Latino patients. *Journal of Diabetes Science and Technology,* 7(1), 111-118.

Caburnay, C. A., Graff, K., Harris, J. K., McQueen, A., Smith, M., Fairchild, M., &

Kreuter, M. W. (2015). Evaluating diabetes mobile applications for health literate designs and functionality, 2014. *Preventing Chronic Disease*, 12, e61. http://dx.doi.org/10.5888/pcd12.140433

Calvillo, J., Roman, I., & Roa, L. M. (2013). How technology is empowering patients? A literature review. *Health Expect*, 18(5), 643-652. doi: 10.1111/hex.12089

Camerini, L., Schulz, P. J., & Nakamoto, K. (2012). Differential effects of health knowledge and health empowerment over patients' self-management and health outcomes: A cross-sectional evaluation. *Patient Education and Counseling,* 89(2), 337-344. http://dx.doi.org/10.1016/j.pec.2012.08.005

Capozza, K., Woolsey, S., Georgsson, M., Black, J., Bello, N., Lence, C., ... North, C. 2015). Going mobile with diabetes support: A randomized study of a text message–based personalized behavioral intervention for type 2 diabetes self-care. *Diabetes Spectrum,* 28(2), 83-91. http://dx.doi.org/10.2337/diaspect.28.2.83

Cartwright, T., & Torr, R. (2005). Making sense of illness: The experiences of users of complementary medicine. *Journal of Health Psychology,* 10(4), 559-572. http://dx.doi.org/10.1177/1359105305053425

Chan, J. C. N., Malik, V., Jia, W., Kadowaki, T., Yajnik, C. S., Yoon, K.-H., & Hu, F. B. (2009). Diabetes in Asia: Epidemiology, risk factors, and pathophysiology. *JAMA,* 301(20), 2129-2140. http://dx.doi.org/10.1001/jama.2009.726

Cheng, Tsung O (2011). Diabetes epidemic in China and its economic impact.

International Journal of Cardiology 19, 1-3, doi: 10.1016/j.ijcard.2011.01.009

Cherrington, A. L., Agne, A. A., Lampkin, Y., Birl, A., Shelton, T. C., Guzman, A., & Willig, J. H. (2015). Diabetes Connect: Developing a mobile health intervention to link diabetes community health workers with primary care. *Journal of Ambulatory Care Management,* 38(4), 333-345. http://dx.doi.org/10.1097/JAC.0000000000000110

Chew, B. H., Shariff-Ghazali, S., & Fernandez, A. (2014). Psychological aspects of diabetes care: effecting behavioral change in patients. *World J Diabetes,* 5(6), 796-808. doi: 10.4239/wjd.v5.i6.796.

Chomutare, T., Fernandez-Luque, L., Årsand, E., & Hartvigsen, G. (2011). Features of mobile diabetes applications: Review of the literature and analysis of current applications compared against evidence-based guidelines. *Journal of Medical Internet Research,* 13(3), e65. http://dx.doi.org/10.2196/jmir.1874

Cobden, D. S., Niessen, L. W., Barr, C. E., Rutten, F. F. H., & Redekop, W. K. (2010). Relationships among self-management, patient perceptions of care, and health economic outcomes for decision-making and clinical practice in type 2 diabetes. *Value in Health,* 1(1), 138-147. http://dx.doi.org/10.1111/j.1524-4733.2009.00587.x

Committee on the Quality of Health Care in America, Institute of Medicine (2001).

Crossing the quality chasm: A new health system for the 21st century. Washington, DC: National Academy Press.

Cotterez, A. P., Durant, N., Agne, A. A., & Cherrington, A. L. (2014). Internet interventions to support lifestyle modification for diabetes management: A systematic review of the evidence. *Journal of Diabetes and Its Complications,* 28(2), 243-251. http://dx.doi.org/10.1016/j.jdiacomp.2013.07.003

Cronbach, L. J. (1951). Coefficient alpha and the internal structure of tests. *Psychometrika,* 16(3), 297-334. http://dx.doi.org/10.1007/BF02310555

Deber, R. B., Kraetschmer, N., & Irvine J. (1996). What role do patients wish to play in treatment decision making? *Archives of Internal Medicine,* 156(13), 1414-1420. http://dx.doi.org/10.1001/archinte.1996.00440120070006Delamater, A. M. (2006). Improving patient adherence. *Clinical Diabetes,* 24(2), 71-77. doi: 10.2337/diaclin.2.2,71.

Demidowich, A. P., Lu, K., Tamler, R., & Bloomgarden, Z. (2012). An evaluation of diabetes self-management applications for Android smartphones. *Journal of Telemedicine and Telecare,* 18(4), 235-238. http://dx.doi.org/10.1258/jtt.2012.111002

Drennan, J. (2003). Cognitive interviewing: Verbal data in the design and pretesting of questionnaires. *Journal of Advanced Nursing,* 42(1), 57-63. http://dx.doi.org/10.1046/j.1365-2648.2003.02579.x

El-Gayar, O., Timsina, P., Nawar, N., & Eid, W. (2013). Mobile applications for diabetes self-management: Status and potential. *Journal of Diabetes Science and Technology,* 7(1), 247-262. http://dx.doi.org/10.1177/193229681300700130

Ebrahimi, H., Sadeghi, M., Amanpour, F., & Vahedi, H. (2016). Evaluation of empowerment model on indicators of metabolic control in patients with type 2 diabetes, a randomized clinical trial study. *Prim Care Diabetes,* 10(2), 129-135. doi: 10.1016/j.pcd.2015.09.003

Elbert, N. J., van Os-Medendorp, H., van Renselaar, W., Ekeland, A. G., Hakkaart-van Roijen, L., Raat, H., . . . Pasmans, S. G. (2014). Effectiveness and cost-effectiveness of eHealth interventions in somatic diseases: A systematic review of systematic reviews and meta-analyses. *Journal of Medical Internet Research,* 16(4), e110. http://dx.doi.org/10.2196/jmir.2790

Ende, J., Kazis, L., Ash, A., & Moskowitz, M. (1989). Measuring patients' desire for autonomy: Decision making and information-seeking preferences among medical patients. *Journal of General Internal Medicine,* 4(1), 23-30. http://dx.doi.org/10.1007/BF02596485

Epstein, R. M., Alper, B. S., & Quill, T. E. (2004). Communicating evidence for participatory decision making. *JAMA,* 291(19), 2359-2366. http://dx.doi.org/10.1001/jama.291.19.2359

Epstein, R. M., & Street, R. L. (2011). The values and value of patient-centered care.

Annals of Family Medicine, 9(2), 100-103. http://dx.doi.org/10.1370/afm.1239

Eysenbach, G. (2001). What is e-health? *Journal of Medical Internet Research*, 3(2), e20. http://dx.doi.org/10.2196/jmir.3.2.e20

Eysenbach, G. (2014). The new health-related top-level domains are coming: Will cureforcancer.health go to the highest bidder? *Journal of Medical Internet Research,* 16(3), e73. http://dx.doi.org/10.2196/jmir.3358

Eysenbach, G., Powell, J., Kuss, O., & Sa, E.-R. (2002). Empirical studies assessing the quality of health information for consumers on the world wide web: A systematic review. *JAMA,* 287(20), 2691-2700. Fox, S., & Duggan, M. (2012). Mobile health 2012. Washington, DC: PewResearchCenter. http://www.pewinternet.org/2012/11/08/mobile-health-2012/

Fox, S., & Purcell, K. (2010). Chronic disease and the Internet: Adults living with chronic disease are disproportionately offline in an online world. Washington, DC: PewResearchCenter. http://www.pewinternet.org/2010/03/24/chronic-disease-and-the-internet

Funnell, M. M., & Anderson, R. M. (2004). Empowerment and self-management of diabetes. *Clinical Diabetes,* 22, 123-127.

Germanakos, P., Mourlas, C., & Samaras, G. (2005). A mobile agent approach for ubiquitous and personalized eHealth information systems. Retrieved from http://cgi.csc.liv.ac.uk/~floriana/UM05-eHealth/Germanakos.pdf

Goh, G., Tan, N. C., Malhotra, R., Padmanabhan, U., Barbier, S., Allen, J. C., & Ostbye, T. (2015). Short-term trajectories of use of a caloric-monitoring mobile phone app among patients with type 2 diabetes melitus in a primary care setting. *Journal of Medical Internet Research,* 17, e23. http://dx.doi.org/10.2196/jmir.3938

Green, A. R., Carrillo, J. E., & Betancourt, J. R. (2002). Why the disease-based model of medicine fails our patients. *Western Journal of Medicine,* 176(2), 141-143.

Guariguata, L., Whiting, D. R., Hambleton, I., Beagley, J., Linnenkamp, U., & Shaw, J. E. (2014). Global estimates of diabetes prevalence for 2013 and projections for 2035. *Diabetes Research and Clinical Practice,* 103(2), 137-149. http://dx.doi.org/10.1016/j.diabres.2013.11.002

Haas, L., Maryniuk, M., Beck, J., Cox, C. E., Duker, P., Edwards, L., . . . Youssef, G. (2013). National standard for diabetes self-management education and support. *Diabetes Care,* 36(Suppl. 1), S100-S108. http://dx.doi.org/10.2337/dc13-s100

Haddad, N. S., Istepanian, R., Philip, N., Khazaal, F. A. K., Hamdan, T. A., Pickles, T., Gregory, J. W. (2014). A feasibility study of mobile phone text messaging to support education and management of type 2 diabetes in Iraq. *Diabetes Technology & Therapeutics,* 16(7), 454-459. http://dx.doi.org/10.1089/dia.2013.0272

Hartin, P. J., Nugent, C. D., McClean, S. I., Cleland, I., Tschanz, J. T., Clark, C. J., &

Norton, M. C. (2016). The empowering role of mobile apps in behavior change interventions: the gray matters randomized controlled trial. *JMIR Mhealth Uhealth*, 4(3), e93. doi: 10.2196/mhealth.4878

Hassan, A., Meo, S. A., Usmani, A. M., & Shaikh, T. J. (2014). Diabetes during Ramadan—PRE-approach model: Presentation, risk stratification, education. *European Review for Medical and Pharmacological Sciences,* 18(12), 1798-1805.

Hawk, C., Ndetan, H., & Evans, M. W., Jr. (2012). Potential role of complementary and alternative health care providers in chronic disease prevention and health promotion: An analysis of National Health Interview Survey data. *Preventive Medicine,* 54(1), 18-22. http://dx.doi.org/10.1016/j.ypmed.2011.07.002

Healthy People 2020. (2010). Retrieved from HealthyPeople.gov.

Hernandez-Tejada, M. A., Campbell, J. A., Walker, R. J., Smalls, B. L., Davis, K. S., & Egede, L. E. (2012). Diabetes empowerment, medication adherence and self-care behaviors in adults with type 2 diabetes. *Diabetes Technology & Therapeutics,* 14(7), 630-634. http://dx.doi.org/10.1089/dia.2011.0287

Hibbard, J. H., & Jewett, J. J. (1996). What type of quality information do consumers want in a health care report card? *Medical Care Research and Review*, 53(1), 28-47. http://dx.doi.org/10.1177/107755879605300102

Hu, F. B. (2011). Globalization of diabetes. *Diabetes Care,* 34(6), 1249-1257. http://dx.doi.org/10.2337/dc11-0442

Hu, H., Li, G., Duan, J., & Arao, T. (2013). Prevalence, purposes, and perceived effectiveness of complementary and alternative medicine use in a hypertension population: A questionnaire survey. ISRN Public Health, 2013, 137472. http://dx.doi.org/10.1155/2013/137472

Hua, W., Cao, S., Cui, J., Maberley, D., & Matsubara, J. (2013). Analysis of reasons for noncompliance with laser treatment in patients of diabetic retinopathy. *Canadian Journal of Ophthalmology,* 48(2), 88-92. http://dx.doi.org/10.1016/j.jcjo.2012.09.012.

Jodel X, (2011). What is QQ. INFOMORY.COM. Retrieved from http://infomory.com/what-is/what-is-qq/

Karhula, T., Vuorinen, A.-L., Rääpysjärvi, K., Pakanen, M., Itkonen, P., Tepponen, M., Saranummi, N. (2015). Telemonitoring and mobile phone-based health coaching among Finnish diabetic and heart disease patients: Randomized controlled trial. *Journal of Medical Internet Research,* 17(6), e153. http://dx.doi.org/10.2196/jmir.4059

Kart, C. (2016). How mobile health can improve patient care and provider profitability. Retrieved December 3rd, 2016, from http://www.healthcarebusinesstoday.com/rick-kimball-hexl-mobile-health-improve-patient-care-provider-profitability/

Khanna, R., Stoddard, P. J., Gonzales, E. N., Villagran-Flores, M., Thomson, J., Bayard, P., Gonzales, R. (2014). An automated telephone nutrition support system for Spanish-speaking patients with diabetes. *Journal of Diabetes Science and Technology*, 8(6), 1115-1120. http://dx.doi.org/10.1177/1932296814550186

Koppes, L. L. J., Dekker, J. M., Hendriks, H. F. J., Bouter, L. M., & Heinem, R. J. (2005). Moderate alcohol consumption lowers the risk of type 2 diabetes. *Diabetes Care,* 28(3), 719-725. http://dx.doi.org/10.2337/diacare.28.3.719

Lam, C. S., Hsang, H. W., Corrigan, P. W., Lee, Y., Beth, A., Shi, K., Jin, S., Larson, J. E. (2010). Chinese lay theory and mental illness stigma: implications for research and practices. *Journal of Rehabilitation*, 76 (1), 35-40.

Lee, J. H. (2016). Future of the smartphone for patients and healthcare providers. *Healthc Inform Res,* 22(1), 1-2. doi: 10.4258/hir.2016.22.1.1

Lee, R. N. (1986). The Chinese perception of mental illness in the Canadian mosaic. *Canada's Mental Health,* 34 (4), 2-4.

Levine, J. A. (2008). Obesity in China: Causes and solutions. *Chinese Medical Journal,* 121(11), 1043-1050.

Li, H., Oldenburg, B., Chamberlain, C., O'Neil, A., Xue, B., Damien, J., ... Guo, Y. (2012). Diabetes prevalence and determinants in adults in China mainland from 2000 to 2010: A systematic review. *Diabetes Research and Clinical Practice,* 98(2), 226-235. http://dx.doi.org/10.1016/j.diabres.2012.05.010

Li, M., Su, L., Liang, B., Tan, J., Chen, Q., Long, J., ... Gu, L. (2013). Trends in prevalence, awareness, treatment, and control of diabetes mellitus in mainland China from 1979 to 2012. *International Journal of Endocrinology*, 2013, 753150. http://dx.doi.org/10.1155/2013/753150

Li, S., Guo, S., He, F., Zhang, M., He, J., Yan, Y., . . . Ma, R. (2015). Prevalence of diabetes mellitus and impaired fasting glucose, associated with risk factors in rural Kazakh adults in XinJiang, China. *Internatonal Journal of Environmental Research and Public Health,* 12(1), 554-565. http://dx.doi.org/10.3390/ijerph120100554

Li, X., Zhan, Y., Wang, Q., Xu, Y., Liu, Y., Wang, X., & Ren, Y. (2015). A sneak peak of the 2015 report on the market of type 2 diabetes mellitus diagnosis and treatment in China. *Annals of Translational Medicine,* 3(9), 120. http://dx.doi.org/10.3978/j.issn.2305-5839.2015.06.09

Lim, S., Kang, S. M., Kim, K. M., Moon, J. H., Choi, S. H., Hwang, H., . . . Jang, H. C. (2015). Multifactorial intervention in diabetes care using real-time monitoring and tailored feedback in type 2 diabetes. *Acta Diabetologica*, 53(2), 189-198. http://dx.doi.org/10.1007/s00592-015-0754-8

Lin, P.-H., Wang, Y., Levine, E., Askew, S., Lin, S., Chang, C., . . . Bennett, G. G. (2014). A text messaging-assisted randomized lifestyle weight loss clinical trial among overweight adults n Beijing. *Obesity,* 22(5), E29-E37. http://dx.doi.org/10.1002/oby.20686

Logan, A. G., Irvine, M. J., McIsaac, W. J., Tisler, A., Rossos, P. G., Easty, A., ... Cafazzo, J. A. (2012). Effect of home blood pressure telemonitoring with self-care support on uncontrolled systolic hypertension in diabetics. *Hypertension,* 60(1), 51-57. http://dx.doi.org/10.1161/HYPERTENSIONAHA.111.188409

Long, A. (2011). Complementary and alternative medicine: What physicians should know. *Rx for Prevention*, 2(9), 1-6.

Lyles, C. R., Harris, L. T., Le, T., Flowers, J., Tufano, J., Britt, D., ... Ralston, J. D. (2011). Qualitative evaluation of a mobile phone and web-based collaborative care intervention for patients with type 2 diabetes. *Diabetes Technology & Therapeutics,* 13(5), 563-569. http://dx.doi.org/10.1089/dia.2010.0200

Lyles, C. R., Schilinger, D., Lopez, A., Handley, M., Ratanawongsa, N., & Sarkar, U. (2013). Safety events during an automated telephone self-management support intervention. *Journal of Diabetes Science and Technology*, 7(3), 596-601. http://dx.doi.org/10.1177/193229681300700303

Ma, J., Xiao, L., & Blonstein, A. C. (2013). Measurement of self-monitoring web technology acceptance and use in an e-health weight-loss trial. *Telemedicine and e-Health,* 19(10), 739-745. http://dx.doi.org/10.1089/tmj.2013.0009

Martínez-Pérez, B., de la Torre-Díez, I., & López-Coronado, M. (2013). Mobile health applications for the most prevalent conditions by the World Health Organization: Review and analysis. *Journal of Medical Internet Research,* 15(6), e120. http://dx.doi.org/10.2196/jmir.2600

McAllister, M., Dunn, G., Payne, K., Davies, L., & Todd, C. (2012). Patient empowerment: The need to consider it as a measurable patient-reported outcome for chronic conditions. *BMC Health Services Research,* 12, 157. http://dx.doi.org/10.1186/1472-6963-12-157

McNutt, R. A. (2004). Shared medical decision making: Problems, process, progress. *JAMA,* 292(20), 2516-2518. http://dx.doi.org/10.1001/jama.292.20.2516

mobiThinking, M. (2014). Global mobile statistics 2014 Part A: Mobile subscribers; handset market share; mobile operators. mobiForge. Retrieved from https://mobiforge.com/research-analysis/global-mobile-statistics-2014-part-a-mobile-subscribers-handset-market-share-mobile-operators

Mühlhauser, I., Albrecht, M., & Steckelberg, A. (2015). Evidence-based health information and risk competence*.* *German Medical Science,* 13, 11. http://dx.doi.org/10.3205/000215

Nagrebetsky, A., Larsen, M., Craven, A., Turner, J., McRobert, N., Murray, E., ... Farmer, A. (2013). Stepwise self-titration of oral glucose-lowering medication using a mobile telephone-based telehealth platform in type 2 diabetes: A feasibility trial in primary care. *Journal of Diabetes Science and Technology,* 7(1), 123-134. http://dx.doi.org/10.1177/193229681300700115

Näsström, L., Jaarsma, T., Idvall, E., Årestedt, K., & Strömberg, A. (2014). Patient participation in patients with heart failure receiving structured home care—a prospective longitudinal study. BMC Health Services Research, 14, 633. http://dx.doi.org/10.1186/s12913-014-0633-y

Nathan, D. M. (1993). Long-term complications of diabetes mellitus. *The New England Journal of Medicine,* 328(23), 1676-1685.

Nes, A. A. G., Eide, H., Kristjánsdóttir, O. B., van Dulmen, S. (2013). Web-based, self-management enhancing interventions with e-diaries and personalized feedback for persons with chronic illness: A tale of three studies. *Patient Education and Counseling,* 93(3), 451-458. http://dx.doi.org/10.1016/j.pec.2013.01.022

Nie, L., Xie, B., Yang, Y., Shan, Y. M. (2016). Characteristics of Chinese mHealth applications for diabetes self-management *Telemedicine and eHealth,* 22(7), 614-619. http://dx.doi.org/10.1089/tmj.2015.0184

Nunnally, J. C. & Bernstein, I. H. (1994). Psychometric Theory. (3rd ed.). New York: McGraw – Hill.

Orsama, A.-L., Lähteenmäki, J., Harno, K., Kulju, M., Wintergerst, E., Schachner, H., ... Fisher, W. A. (2013). Active assistance technology reduces glycosylated hemoglobin and weight in individuals with type 2 diabetes: Results of a theory-based randomized trial. *Diabetes Technology & Therapeutics,* 15(8), 662-669. http://dx.doi.org/10.1089/dia.2013.0056

Osborn, C. Y., & Mulvaney, S. A. (2013). Development and feasibility of a text messaging and interactive voice response intervention for low-income, diverse adults with type 2 diabetes mellitus. *Journal of Diabetes Science and Technology,* 7(3), 612-622.

Page, N., & Czuba, C. E. (1999). Empowerment: What is it? Journal of Extension, 37(5).

Park, L. G., Howie-Esquivel, J., & Dracup, K. (2014). A quantitative systematic review of the efficacy of mobile phone interventions to improve medication adherence. *Journal of Advanced Nursing,* 70(9), 1932-1953. http://dx.doi.org/10.1111/jan.12400

Patterson, S. (2011, April 8). Obesity in China: Waistlines are expanding twice as fast as GDP. US-China Today. Retrieved from http://www.uschina.usc.edu/article@usct?obesity_in_china_waistlines_are_expanding_twice_as_fast_as_gdp_16595.aspx

Paulweber, B, Valensi, P., Lindström, J, Lalic, N. M., Greaves, C. J., Mckee, M., ... Yilmaz, T. (2010). A European evidence-based guideline for the prevention of type 2 diabetes. *Hormone and Metabolic Research*, 42(Suppl. 1), S3-S36. http://dx.doi.org/10.1055/s-0029-1240928

Peña-Purcell, N. C., Boggess, M. M., & Jimenez, N. (2011). An empowerment-based diabetes self-management education program for Hispanic/Latinos: A quasi-experimental pilot study. *The Diabetes Educator,* 37(6), 770-779. http://dx.doi.org/10.1177/0145721711423319

Pew Global Attitudes Project. (2011). Global digital communication: Texting, social networking poolar worldwide. PewResearchCenter. Retrieved from ://www.pewglobal.org/2011/12/20/global-digital-communication-texting-social-networking-popular-worldwide/

Pew Research Center. (2017). China outpaces India in internet access, smartphone ownership. Retrieved from http://www.pewresearch.org/fact-tank/2017/03/16/china-outpaces-india-in-internet-access-smartphone-ownership/

Pew Research Center. (2016). Global attitudes & treads. Smartphone ownership & Internet usage continues to climb in emerging economies. Retrieved from http://www.pewglobal.org/2016/02/22/smartphone-ownership-and-internet-usage-continues-to-climb-in-emerging-economies/

Pew Research Center. (2013). Health Tracking Survey 2012. Retrieved from http://www.pewinternet.org/files/old-media/Files/Questionnaire/2013/Pew%20Internet%20Health%20Online%20topline.pdf

Pew Research Center. (2013). Internet adoption becomes nearly universal among some groups, but others lag behind. Retrieved from http://www.pewresearch.org/fact-tank/2013/05/30/internet-adoption-becomes-nearly-universal-among-some-groups-but-others-lag-behind/

Pew Research Center. (2014). Mobile technology fact sheet. Retrieved from http://www.Available at pewinternet.org/fact-sheets/mobile-technology-fact-sheet.

Pew Research Center. (2015). U.S. smartphone use in 2015. Retrieved from http://www.pewinternet.org/files/2015/03/PI_Smartphones_0401151.pdf

Pew Research Center. (2013). Tracking for health. Retrieved from http://pewinternet.org/Reports/2013/Tracking-for-Health.aspx

Piette, J. D., Farris, K. B., Newman, S., An, L., Sussman, J., & Singh, S. (2015). The potential impact of intelligent systems for mobile health self-management support: Monte Carlo simulations of text message support for medicaion adherence. *Annals of Behavioral Medicine,* 49(1), 84-94. http://dx.doi.org/10.1007/s12160-014-9634-7

Pludwinski, S., Ahmad, F., Wayne, N., & Ritvo, P. (2016). Participant experiences in a smartphone-based health coaching intervention for type 2 diabetes: A qualitative inquiry. *Journal of Telemedicine and Telecare,* 22(3), 172-178. http://dx.doi.org/10.1177/1357633X15595178

Quinn, C. C., Khokhar, B., Weed, K., Barr, E., & Gruber-Baldini, A. L. (2015). Older adult self-efficacy study of mobile phone diabetes management. *Diabetes Technology & Therapeutics,* 17(7), 455-461. http://dx.doi.org/10.1089/dia.2014.0341

Quinn, C. C., Shardell, M. D., Terrin, M. L., Barr, E. A., Ballew, S. H., & Gruber-Baldini, A. L. (2011). Cluster-randomized trial of a mobile phone personalized behavioral intervention for blood glucose control. *Diabetes Care,* 34(9), 1934-1942. http://dx.doi.org/10.2337/dc11-0366

Ribu, L., Holmen, H., Torbjørnsen, A., Wahl, A. K., Grøttland, A., Småstuen, M. C., ... Årsand, E. (2013). Low-intensity self-managment intervention for persons with type 2 diabetes using a mobile phone-based diabetes diary, with and without health counseling and motivational interviewing: Protocol for a randomized controlled trial. *JMIR Research Protocols*, 2(2), e34. http://dx.doi.org/10.2196/resprot.2768

Ristau, R. A., Yang, J., & White, J. R. (2013). Evaluation and evolution of diabetes mobile applications: Key factors for health care professionals seeking to guide patients. *Diabetes Spectrum,* 26(4), 211-215. http://dx.doi.org/10.2337/diaspect.26.4.211

Rossi, M. C., Lucisano, G., Funnell, M., Pintaudi, B., Bulotta, A., Gentile, S., ... Nicolucci, A. (2015). Interplay among patient empowerment and clinical and person-centered outcomes in type 2 diabetes. The BENCH-D study. *Patient*

Education and Counseling, 98(9), 1142-1149. http://dx.doi.org/10.1016/j.pec.2015.05.012

Rouse, M. (2016). mHealth. TechTarget web site. Retrieved from http://searchhealthit.techtarget.com/definition/mHealth

Scheibe, M., Reichelt, J., Bellmann, M., & Kirch, W. (2015). Acceptance factors of mobile apps for diabetes by patients aged 50 or older: A qualitative study. *Medicine* 2.0, 4(1), e1. http://dx.doi.org/10.2196/med20.3912

Shaw, J. E., Sicree, R. A., & Zimmet, P. Z. (2010). Global estimates of the prevalence of diabetes for 2010 and 2030. *Diabetes Research and Clinical Practice,* 87(1), 4-14. http://dx.doi.org/0.1016/j.diabres.2009.10.007

Shetty, G. K., & Hsu, W. (2016). Empowering patients with diabetes using mobile health technology. *Empower,* 5.

Sibal, L., & Home, P. D. (2009). Management of type 2 diabetes: NICE guidelines. *Clinical Medicine,* 9(4), 353-357. http://dx.doi.org/10.7861/clinmedicine.9-4-353

Silver, M. P. (2015). Patient perspectives on online health information and communication with doctors: A qualitative study of patients 50 years old and over. *Journal of Medical Internet Research,* 17(1), e19. http://dx.doi.org/10.2096/jmir.3588

Simon, D., Kriston, L., Loh, Andreas., Spies, C., Scheibler, F., Wills, C., Harter, M.

(2010). Confirmatory factor analysis and recommendations for improvement of the autonomy-preference-index (API). *Health Expectations,* 13, 234-243. http://onlinelibrary.wiley.com/doi/10.1111/j.1369-7625.2009.00584.x/full

Sixth National Population Census of the People's Republic of China (2010 Chinese Census, 2010). Retrieved from https://en.wikipedia.org/wiki/Sixth_National_Population_Census_of_the_People%27s_Republic_of_China#Educational_attainment

Smart, J. M., & Burling, D. (2001). Radiology and the Internet: A systematic review of atient information resources. *Clinical Radiology,* 56(11), 867-870. http://dx.doi.org/10.1053/crad.2001.0738

Smith, D. H, Smith, S. J (1999) Chinese elders' communication about medicine. *Health Communication.* 11(3), 237-248

Starcevic, V., & Berle, D. (2013). Cyberchondria: Towards a better understanding of excessive health-related Internet use. *Expert Review of Neurotherapeutics*, 13(2), 205-213. http://dx.doi.org/10.1586/ern.12.162

Stiggelbout, A. M., & Kiebert, G. M. (1997). A role for the sick role: Patient preferences regarding information and participation in clinical decision-making. *CMAJ,* 157(4), 383-389.

Sultan, S., & Mohan, P. (2012). Self-regulated learning in a mobile health initiative for diabetic patients. In IEEE International Conference on Advanced Learning

Technologies (pp. 706-707). Washington, DC: IEEE Computer Society.

Tang, W. K., Ungvari, G. S., & Chan, G. W. L. (2002). Patients' and their relatives' knowledge of, experience with, attitude toward, and satisfaction with electroconvulsive therapy in Hong Kong, China. *The Journal of ECT*, 18(4), 207-212.

Tatara, N., Årsand E., Skrøvseth, S. O., & Hartvigsen, G. (2013). Long-term engagement with a mobile self-management system for people with type 2 diabetes. *JMIR Mhealth Uhealth,* 1(1), e1. http://dx.doi.org/10.2196/mhealth.2432

Tol, A., Alhani, F., Shojaeazadeh, D., Sharifirad, G., & Moazam, N. (2015). An empowering approach to promote the quality of life and self-management among type 2 diabetic patients. *Journal of Education and Health Promotion*, 4, 3. http://dx.doi.org/10.4103/2277-9531.154022

van Berkel, J. J., Lambooij, M. S., & Hegger, I. (2015). Empowerment of patients in online discussions about medicine use. *BMC Medical Informatics and Decision Making*, 15, 24. http://dx.doi.org/10.1186/s12911-015-0146-6

van der Weegen, S., Verwey, R., Spreeuwenberg, M., Tange, H., van der Weijden, T., & de Witte, L. (2015). It's LiFe! mobile and web-based monitoring and feedback tool embedded in primary care increases physical activity: A cluster randomized controlled trial. *Journal of Medical Internet Research*, 7(7), e184. http://dx.doi.org/10.2196/jmir.4579 van Vugt, M., de Wit, M., Cleijne, W. H. J. J., & Snoek, F. J. (2013). Use of behavioral change techniques in web-based self-management programs for type 2 diabetes patients: Systematic review. *Journal of Medical Internet Research*, 15(12). e279. http://dx.doi.org/10.2196/jmir.2800

Verwey, R., van der Weegen, S., Spreeuwenberg, M., Tange, H., van der Weijden, T., & de Witte, L. (2016). Process evaluation of physical activity counselling with and without the use of mobile technology: A mixed methods study. *International Journal of Nursing Studies,* 53, 3-16. http://dx.doi.org/10.1016/j.ijnurstu.2015.10.008

Villegas, R., Liu, S., Gao, Y.-T., Yang, G., Li, H., Zheng, W., Shu, X. O. (2007). Prospective study of dietary carbohydrates, glycemic index, glycemic load, and incidence of type 2 diabetes mellitus in middle-aged Chinese women. *JAMA Internal Medicine*, 167(21), 2310-2316. http://dx.doi.org/10.1001/archinte.167.21.2310

Waki, K., Fujita, H., Uchimura, Y., Omae, K., Aramaki, E., Kato, S., . . . Ohe, K. (2014). DialBetics: A Novel Smartphone-based Self-management Support System for Type 2 Diabetes Patients. *Journal of Diabetes Science and Technology,* 8(2), 209-215. http://dx.doi.org/10.1177/1932296814526495

Wayne, N., Perez, D. F., Kaplan, D. M., & Ritvo, P. (2015). Health coaching reduces

HbA1c in type 2 diabetic patients from a lower-socioeconomic status community: A randomized controlled trial. *Journal of Medical Internet Research*, 17(10), e224. http://dx.doi.org/10.2196/jmir.4871

Weymann, N., Härter, M., & Dirmaier, J. (2013). A tailored, interactive health communication application for patients with type 2 diabetes: Study protocol of a randomised controlled trial. *BMC Medical Informatics and Decision Making,* 13, 24. http://dx.doi.org/10.1186/1472-6947-13-24

Weymann, N., Härter, M., & Dirmaier, J. (2015). Quality of online information on type 2 diabetes: A cross-sectional study. *Health Promotion International,* 30(4), 821-831. http://dx.doi.org/10.1093/heapro/dau019

Weymann, N., Härter, M., & Dirmaier, J. (2016). Information and decision support needs in patients with type 2 diabetes. *Health Informatics Journal*, 22(1), 46-59. http://dx.doi.org/10.1177/1460458214534090

Weymann, N., Dirmaier, J., von Wolff, A., Kriston, L., & Härter, M. (2015). Effectiveness of a web-based tailored interactive health communication application for patients with type 2 diabetes or chronic low back pain: Randomized cotrolled trial. *Journal of Medical Internet Research,* 17(3), e53. http://dx.doi.org/10.2196/jmir.3904

What Is WeChat? (2017, April 12). *Computer Business Review*. Retrieved from http://www.cbronline.com/what-is/what-is-wechat-4958158.

Wildevuur, S. E., & Simonse, L. W. (2015). Information and communication technology-enabled person-centered care for the “big five” chronic conditions: Scoping review. *Journal of Medical Internet Research,* 17(3), e77. http://dx.doi.org/10.2196/jmir.3687

Williams, E. D., Bird, D., Forbes, A. W., Russell, A., Ash, S., Friedman, R., ... & Oldenburg, B. (2012). Randomised controlled trial of an automated, interactive telephone intervention (TLC Diabetes) to improve type 2 diabetes management: Baseline findings and six-month outcomes *BMC Public Health,* 12, 602. http://dx.doi.org/10.1186/1471-2458-12-602

Wong, E. L. Y., Woo, J., Hui, E., Chan, C., Chan, W. L. S., & Cheung, A. W. L. (2011). Primary care for diabetes mellitus: Perspective from older patients. *Patient Preference and Adherence*, 2011(5), 491-498. http://dx.doi.org/10.2147/PPA.S18687

Xi, B., Liang, Y., He, T., Reilly, K. H., Hu, Y., Wang, Q., …. Mi, J. (2012). Secular trends in the prevalence of general and abdominal obesity among Chinese adults, 1993 – 2009. Obes Rev, 13(3), 287-296. Doi:10.1111/j.167-789X.2011.009x.

Xie, B. (2009). Older adults’ health information wants in the Internet age: Implications for patient–provider relationships. *Journal of Health Communication,* 14(6), 510-524. http://dx.doi.org/10.1080/10810730903089614

Xie, B. (2011). Older adults, e-health literacy, and collaborative learning: An experimental study. *Journal of the American Society for Information Science and Technology,* 62(5), 933-946. http://dx.doi.org/10.1002/asi.21507

Xie, B., Su, Z., Liu, Y., Wang, M., & Zhang, M. (2015). Health information wanted and obtained from doctors/nurses: A comparison of Chinese cancer patients and family caregivers. *Supportive Care in Cancer,* 23(10), 2873-2889. http://dx.doi.org/10.1007/s00520-015-2651-7

Xie, B., Wang, M., & Feldman, R. (2011). Preferences for health information and decision-making: Development of the Health Information Wants (HIW) questionnaire. In iConference’11: Proceedings of the 2011 iConference (pp. 273-280). New York: ACM. http://dx.doi.org/10.1145/1940761.1940799

Xie, B., Wang, M., Feldman, R., & Zhou, L. (2010). Health information and decision-making preferences in the Internet age: A pilot study using the Health Information Wants (HIW) Questionnaire. In IHI ’10: Preceedings of the 1st ACM International Health Informatics Symposium (pp. 610-119). New York: ACM. http://dx.doi.org/10.1145/1882992.1883090

Xie, B., Wang, M., Feldman, R., & Zhou, L. (2013). Internet use frequency and patient-centered care: Measuring patient preferences for participation using the Health Information Wants Questionnaire. *Journal of Medical Interrnet Research*, 15(7), e132. http://dx.doi.org/10.2196/jmir.2615

Xie, B., Wang, M., Feldman, R., & Zhou, L. (2014). Exploring older and younger adults' preferences for health information and participation in decision making using the Health Information Wants Questionnaire (HIWQ). *Health Expectations*, 17(6), 795-808. http://dx.doi.org/10.1111/j.1369-7625.2012.00804.x

Xu, H., Song, Y., You, N.-C., Zhang, Z.-F., Greenland, S., Ford, E. S., ... Liu, S. (2010). Prevalence and clustering of metabolic risk factors for type 2 diabetes among Chinese adults in Shanghai, China. *BMC Public Health,* 10, 683. http://dx.doi.org/10.1186/1471-2458-10-683

Xu, Y., Wang, L., He, J., Bi, Y., Li, M., Wang, T., ... Ning, G. (2013). Prevalence and control of diabetes in Chinese adults. *JAMA,* 310(9), 948-959. http://dx.doi.org/10.1001/jama.2013.168118

Yang, L. (2011). Tobacco control necessary. China Daily Report.

Yang, S., Hsue, C., & Lou, Q. (2014). Does patient empowerment predict self-care behavior and glycosylated hemoglobin in Chinese patients with type 2 diabetes? *Diabetes Technology & Therapeutics*, 17(5), 343-348. http://dx.doi.org/10.1089/dia.2014.0345

Yang, W., Lu, J., Weng, J., Jia, W., Ji, L., Xiao, J., ... He, J. (2010). Prevalence of diabetes among men and women in China. *The New England Journal of Medicine*, 362, 1090-1101. http://dx.doi.org/10.1056/NEJMoa0908292

Young-Hyman, D., de Groot, M., Hill-Briggs, F., Gonzalez, J. S., Hood, K., & Peyrot, M.

(2016). Psychosocial care for people with diabetes: a position statement of the American diabetes association. *Diabetes Care,* 39(12), 2126-2140. doi: 10.2337/dc16-2053

Zhang, Y., Sun, Y., & Xie, B. (2015). Quality of health information for consumers on the Web: a systematic review of indicators, criteria, tools, and evaluation results. *Journal of the association for information science and technology,* 66(10), 2071-2208. doi:10.1002/asi.2311

Zhao, D., Zhao, F., Li, Y., & & Zheng, Z. (2012). Projected and observed diabetes mellitus epidemics in China and beyond. Current Cardiology Reports, 14(1), 106-111. http://dx.doi.org/10.1007/s11886-011-0227-9

Zhou, W., Chen, M., Yuan, J., & Sun, Y. (2016). Welltang - A smart phone-based diabetes management application - Improves blood glucose control in Chinese people with diabetes. *Diabetes Res Clin Pract,* 116, 105-110. doi: 10.1016/j.diabres.2016.03.018

Zhou, Y., Liao, L., Sun, M., & He, G. (2013). Self-care practices of Chinese individuals with diabetes. *Experimental and Therapeutic Medicine*, 5(4), 1137-1142. http://dx.doi.org/10.3892/etm.2013.945

Zuo, H., Shi, Z., & Hussain, A. (2014). Prevalence, trends and risk factors for the diabetes epidemic in China: A systematic review and meta-analysis. *Diabetes Research and Clinical Practice,* 104(1), 63-72. http://dx.doi.org/10.1016/j.diabres.2014.01.002